The Dock and Harbour Authority

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Editorial Comments

Bristol Port in War-Time.

The widespread activities of the Port of Bristol have been the subject of notice in these columns on a number of occasions, the last being in March, 1943. By reason of the war censorship, much that was then being done had perforce to remain untold, especially as regards the steps being taken for the physical development of the port. Now that the veil of secrecy has been lifted, it is with much pleasure that we are able, with the esteemed assistance of Mr. R. H. Jones, until lately the General Manager of the Port Authority, to present to our readers in this issue some account of the extensions in shipping accommodation and of the additions to the port facilities which have been provided in recent years, as also of the important services rendered to the national cause during the war period.

The strategic position of the Port on the West Coast of this country has rendered it particularly valuable for the maintenance of the national commerce and the transport of war material at a time when the Eastern Coast was subject to intensive bombing by aircraft and its ports were more or less obstructed by mines and other obstacles to navigation. At the same time, it has to be admitted that Bristol by no means escaped the dire attentions of the enemy, as is abundantly evidenced by the many terrible, though pride-worthy, scars which have been inflicted on the city and port.

Now that an era of peace has supervened, it will be the warm desire of the numerous well-wishers of the city that it may also be a period of continued prosperity and trade expansion for one of the oldest and most renowned of British seaports.

The Dock Labour Situation.

The Dock Workers (Regulation of Employment) Bill passed its second reading in the House of Commons on November 12th, was committed to a Standing Committee of the House and is now under detailed consideration. The debate on the second reading drew an emphatic protest from certain Labour Members on the implication in the Bill that it was possible for breach of contract of employment to be treated as a criminal offence. Thereupon, the Parliamentary Secretary of the Ministry of Labour gave his assurance that this was not the intention of the measure and that any ordinary breach of contract by a docker would not be regarded as a crime which would bring him before a criminal court. On this assurance, the objectors withdrew their opposition.

The nature and conditions of the "schemes" of operation to be drawn up, either locally by voluntary agreement or ministerially, are at present only conjectural. No doubt, in the main, the standard set by the present schemes under the Essential Work (Dock Labour) Orders will be followed, as such schemes have been found to work fairly satisfactorily and they merely require adaptation to meet the more extended requirements of general application. The main object and intention of the Bill is to put the industry on a sound footing and to give "regular, continuous and well-paid employment to those engaged in it." Such an object must undoubtedly command general approval and induce the hope that it will be effectively achieved.

Meanwhile, the dispute between the dockers' Unions and the Employers, arising out of the demands of the former, continues to be unsettled. On the advice of their Unions, the men reluctantly returned to work on the 4th November, with the sinister threat that, if their demands were not conceded within 30 days, they would foment a national strike of dock workers. This time limit expires almost immediately.

What is so deplorable in this and other recent strikes is the insensibility of the men to the obligations of honour and duty. Agreements, entered into freely and without compulsion, have been disregarded and treated as "merely scraps of paper," in accordance with the teaching of Hitlerism and the German mentality. That such methods should become characteristic of British workmen is truly saddening and augurs badly for the future of the nation.

Slipways

Means for the repair and overhaul of vessels are a paramount necessity at any port of standing, and, though greater and wider scope for the purpose is associated with dry or graving docks and floating docks, yet there is an ample field of usefulness for repairing slipways, especially in the case of craft of small calibre. Indeed, apart from the simple operations of careening and breaching, slipways were probably the earliest means of carrying out re-

Editorial Comments—continued

pairs to the hulls and undersides of vessels, and while their range of action is much inferior to that of the other two systems, particularly in the later developments of these, they are still effective enough, besides being more economical for small craft.

The precise limit of serviceability is not easy to determine. Mr. Minikin, in his article in this month's issue, places it from an economical standpoint, at vessels of 1,000 tons, though he instances a case of 2,000 tons displacement on the Severn Estuary. But slipways have been constructed with capacities considerably in excess of this. At Grimsby, for instance, there is, or was, a slipway of 2,500 tons capacity and another was constructed at Hong Kong (Taikoo Dockyard) before the war of no less than 4,000 tons capacity. We incline to the view that the upper limit may be extended without excessive axle strain to 5,000 tons, say, for a vessel 350 feet in length. Indeed, the introduction of the principle of the live roller, as exemplified in the United States by the marine railways of the Crandall Engineering Company of Boston, has enabled 8,000 tons longitudinally and 10,000 tons broadside to be handled. Slipways of this magnitude have been constructed at Boston and San Francisco.

It may be of interest to our readers to supplement Mr. Minikin's useful article by a brief description of the live roller system, or railway dry dock, as it is termed in America. It differs from the normal slipway in vogue in this country, in that the cradle forms a continuous floor from end to end, the keel block line being horizontal or very slightly inclined. The slope of the track is generally steep, resulting in a very high "build up" of the cradle aft. The cradle is not hauled altogether clear of the water, but merely sufficient for the deck to emerge above tide level, so that the rollers, except in cases of appreciable tidal range, are always submerged. The rollers are generally of small diameter, double-flanged and fitted with axles, or centre pins, running in a frame, consisting of two lines of distance bars, steel flat or angle, or even wood. A number of the rollers, say 10, are mounted in sections, which are coupled together to form a continuous roller frame.

The system is almost universally adopted in America, but it is not popular in this country, probably on account of the inaccessibility of the rollers. There is an absence of assurance that the rollers, set in their frames below water level, have not become deranged in the previous slipping operation, and this, if not discovered in time for rectification, might have awkard consequences.

Port Fire Origins

A lecture recently delivered by Dr. J. B. Firth at a meeting of the Association of Fire Loss Adjusters on "Arson and other Causes of Fires," induces some reflections on the subject of outbreaks of fires at ports, and the means adopted for preventing them. Fires are disastrous affairs at ports, as well as elsewhere. Pre-eminently, of course, a fire on ship at sea can be a terrible experience. No words are needed to heighten the dismay of the ship's officers or the terror of the passengers. But fires at shipping berths can be attended by effects equally disastrous. In port, there ought to be ready means of help and more effective counter-measures. But it is only necessary to mention the calamitous affair at the Port of Bombay last year to show that inefficient organisation can nullify the most elaborate anti-fire precautions.

Dr. Firth enumerated five potential causes of fire, viz., arson, operational processes, negligence, electrical defects and spontaneous combustion. All except, perhaps, one of these are possibilities at the quayside, though some are less minatory than others. Port officials do well to guard particularly against negligence (carelessness in discarding lighted matches and cigarette ends) and defective electric fittings. Spontaneous combustion was largely discounted by Dr. Firth. "It could," he said, "and often did, occur in baled hay." On the other hand, he asserted that spontaneous combustion in baled cotton was an impossibility and he stated emphatically that any belief to the contrary was a fallacy. None the less, the fire in the s.s. *Fort Stikhine* at Bombay Docks broke out in a hold where cotton bales were stowed, and, though it was attributed to the careless discarding of a cigarette end, there was no confirmatory evidence available. The appalling explosion which ensued was caused by the ignited and heated bales coming into contact with the floor plates of the munitions magazine.

The moral is a simple one. Whatever the nature of the agency, the utmost vigilance is necessary to detect fires in their initial stages, when they may still be got under control, and for this purpose trained personnel and efficient organisation are essential.

The Institute of Transport.

The Institute of Transport is seeking a home. Unwilling to depend longer upon the hospitality of kindred Institutions, however cordially rendered, it desires, quite naturally and appropriately, to possess its own premises from which its various activities can be directed and its official business transacted with convenience and dignity. Such has been the main theme of two recent addresses delivered by the President, Sir Frederick Handley Page, and we are glad to give the project such support as lies in our power.

Ports, admittedly, are not in themselves a form of transport, but they are essential adjuncts thereto, especially in an island community, and dock and harbour authorities in Great Britain cannot but view with sympathetic interest any agency which promotes the interchange of goods and the movement of the travelling public. The Institute of Transport exists for the furtherance of these objects, both by sea and land, and during the 25 years of its existence it has done much to foster port activities. It is undoubtedly to be regretted that, generally speaking, hitherto there has not been reflected in the membership of the Institute a corresponding degree of support from port personnel. No doubt this will come eventually, but it is very desirable that it should be forthcoming as soon as possible.

The chief obstacle to the realisation of the Presidential scheme is finance. Having regard to the undoubted benefit of the Institute to the nation at large, it should surely be superfluous to make an appeal for funds to those great Corporations and Companies which are engaged in the transport industry, even if their tenure of administration seem to be threatened by schemes of Nationalisation. Despite the recent confident forecasts of the Government, it is possible these may not materialise for some time, if at all.

Adequate Security.

A rather curious point was discussed before the Liverpool Stipendiary Magistrate in a case reported in our Legal Notes in this issue. It concerned the exact interpretation of a proviso in Docks Regulation No. 42, that hatchway beams must be "adequately" secured. In the course of ship-loading operations a 'thwartship beam over a hatchway of ss. *Prometheus*, became dislodged, so that a hatch cover fell into the hold and fatally injured a labourer who was working below.

Despite the contention of the defendant shipowners that they had done all that they possibly could to prevent dislocation of the beam, H.M. Inspector of Factories claimed a conviction for breach of the Regulation on the ground that the beam had not been adequately secured, in accordance with the requirement, and the magistrate upheld this view, stating that, in his own language, he would have used the word "effectively."

It is rather a nice point in definition. According to Ogilvie's Imperial Dictionary, "adequate" (from the Latin *ad* and *aequatus*, made equal) indicates the quality of being equal to, proportionate or fully sufficient for a particular purpose. Clearly, the security of the beam attachments were insufficient for the occasion, and a layman would have no difficulty in concluding that as "the proof of the pudding is in the eating," the fall of the beam was irrefutable evidence that it was not adequately secured.

A layman's opinion, however, is not necessarily sound in law and it is desirable that the Regulation, which affects the safety of hundreds of men engaged in cargo-handling operations should be clarified so as to exclude any possibility of misapprehension. The defending counsel's arguments showed that a case could be made out for the shipping company's interpretation, although it does not seem quite convincing to the unbiased mind.

Port of Bristol Authority

Recent Dock Extension Work at Avonmouth and Portishead

By R. H. JONES, O.B.E., M.Inst.T.*

IN the *Dock and Harbour Authority*, Vol. 19, No. 225, July, 1939, there were given brief details of the extension work then in hand at Avonmouth.

The extension of the Eastern Arm therein referred to was well in hand on the outbreak of war, and shortly after, in view of the very urgent demand on the western side of the country for additional accommodation, arrangements were made with the Ministry of War Transport to expedite the completion of this Eastern Arm Extension and the construction of the additional oil berths. With, however, the enormous demands for labour and materials, the expediting of the construction of the work was not as rapid as was hoped, and this was also aggravated by the enemy attacks on the docks. The water was let in to the Eastern Arm Extension on the 14th January, 1941, and small craft commenced using it in March, 1941. No. 6 Oil Berth was completed for traffic in March, 1940, but the demolition of the old No. 1 Berth and its reconstruction was greatly delayed for the same reasons as the construction of the Eastern Arm, but this work was eventually completed and available for traffic in July, 1943. The plan on next page shows the original Oil Berth No. 1, as also the new line. It was found that with the additional berths in the Oil Basin, the projection of the original No. 1 Berth tended to interfere with the passing of vessels to the berths at the top end.

As stated in the earlier articles, the Eastern Arm works were constructed by Messrs. Chas. Brand & Son, and the Oil Basin works by Messrs. Christiani & Nielsen. The construction of the "W" Shed on the site indicated on the plan of the Eastern Arm, and illustrated by the accompanying photographs, was entrusted to Messrs. Chas. Brand & Son and this work was completed in 1943. "W" Shed is constructed on pile foundations and is of the slab floor type, the front portion being designed for use as an ordinary transit shed, whereas the rear portion was intended to be used as a floor storage granary, connected to the general grain discharging equipment on the Eastern Arm, but owing to war conditions this section of the work has not yet been carried out and the whole of the floor accommodation is at present available as a transit shed, or some floors can be used for transit purposes and others for storage. From the photograph, it will be seen that the cranes deliver direct from ship to trucks on three lines of railway on the waterside or to road vehicles in the front of the shed. Railway lines are available at platforms at the back of the sheds for goods delivered through the shed. The cranes, it will be noted, can deliver to the upper floors of the sheds, the goods being run back on electric trucks.

MR. F. D. ARNEY (General Manager) | MR. R. H. JONES (Late General Manager) Port of Bristol Officials | MR. W. P. WORDSWORTH (Chief Engineer)

On the east side of the Eastern Arm were provided eight 2-ton electric cranes, together with the necessary railway sidings, capstans, etc., and on the west side, four similar 2-ton cranes, being part of the original scheme, but subsequently to meet the anticipated demands for increased discharging facilities and at the request of the Ministry of War Transport, a further five 3-ton electric cranes were provided on this side of the Extension. These cranes were supplied by Messrs. Stothert & Pitt, Ltd., of Bath.

Subsequent to this equipment, and with the increasing demands for discharge facilities for oil vessels, particularly with the advent of the convoy system, two of the berths at the north end of the Eastern Arm Extension were equipped with pipe lines to enable low-flash oil cargoes to be discharged, and an adjacent berth on the east side was also equipped for the discharge of high-flash oil cargoes. Very special fire precautions had to be taken for the discharge of these cargoes in the general dock and a temporary Admiralty type oil boom was provided to shut off this northern end of the Extension when oil cargoes were being discharged. The provision of these facilities and the extensions in the Oil Basin proper and the Oil Jetty to the north of the North Pier, referred to elsewhere, resulted in giving the port seven berths for the simultaneous discharge of low-flash oils, with the addition of the one referred to for high-flash oil, i.e., eight oil berths in all.

In connection with the petroleum traffic, at the request of the Government, an additional berth was provided outside the dock proper, this berth being shown on the plan. The contractors for this work were Messrs. Holloway Bros., Ltd.

*Until recently, General Manager of the Port of Bristol Authority.

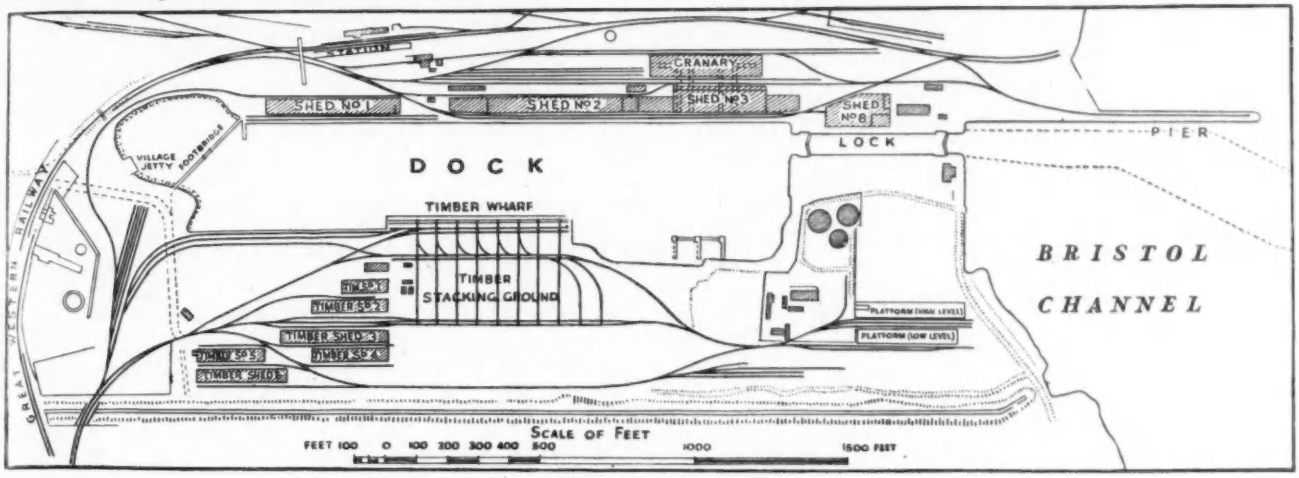
PORT OF BRISTOL AUTHORITY.
ROYAL EDWARD & AVONMOUTH DOCKS.
AVONMOUTH DOCK
ROYAL EDWARD DOCK
EASTERN ARM
EXTENSION AS COMPLETED
OIL BASIN
OIL BERTH No.1
OIL BERTH No.2
OIL BERTH No.3
OIL BERTH No.4
OIL BERTH No.5
OIL BERTH No.6 UNDER CONSTRUCTION
NORTH WALL
DRY DOCK
NORTH PIER
ENTRANCE CHANNEL
SOUTH PIER
EAST PIER
WEST PIER
ENTRANCE CHANNEL
BRISTOL CHANNEL
AVON RIVER
ST GEORGE'S WHARF
To Portishead Dock
BROAD PILL
AVONMOUTH ROAD
PORT VIEW ROAD
C.W.R. Town Goods Sta.
G.W.R. SIDINGS
St Andrew's Rd Sta.
L.M.S. SIDINGS
RECLAMATION FOR DEVELOPMENT
Scale of Feet.

Port of Bristol Authority—continued

The requirements of this berth were to accommodate large tankers drawing up to 32-ft. of water and they had to be kept afloat through any stage of any tide. To enable the discharge to proceed satisfactorily, the work had to be constructed to suit a range of tide between the highest recorded high water and the lowest recorded low water of over 50-ft. This involved the excavation of a deep water basin, as indicated on the plan, and

Portishead Dock

At Portishead Dock, at the request of the Ministry of War Transport, an additional wharf was constructed at the south end of the dock, as shown on the plan. This work, which was carried out by Messrs. Chas. Brand & Son, consisted of a steel sheet pile retaining wall with appropriate ties and the depositing of filling at the back of this wharf; the provision of four 3-ton



Portishead Dock

while the original construction contemplated a solid concrete jetty at which the ships would be moored alongside, the urgency of the work became so great that after considerable preliminary work had been carried out, this scheme was abandoned and a steel piled construction jetty head was provided, linked to the shore by a similarly constructed approach pier, which had been in the original scheme. Owing to the lightness of this construction, however, the ships could not moor alongside, but were moored to six

Oil Berth and Pipe Lines, Avonmouth

floating buoys provided and laid by the Admiralty, and the ships were moored in such a position that they were kept out approximately 50-ft. from the jetty head. This involved a somewhat complicated arrangement of pipe connections from the ship to the jetty, these connecting pipes being slung and swung out to the ship by means of a large derrick crane. While the original intention had been to have only one or two pipe lines connected to the shore, ultimately fourteen pipe lines were provided down the jetty for different classes of oil which had to be handled. This tidal jetty was completed in June, 1943. The accompanying photographs show the jetty and pipe lines as completed.

electric cranes, which were provided by the Ministry of War Transport and built by the Clyde Crane Co., together with the necessary railways on the wharf and standage sidings. This work was completed in March, 1943.

As an appropriate conclusion to the foregoing article, may be inserted a short extract from a previous article by the same writer, contributed to this Journal in March, 1943.

Trade and Future Development at the Port of Bristol

It will be apparent to students of transport that much of Bristol's distributive power and success as a port is due to her geographical position. To illustrate this point it is only necessary to state that within a radius of 100 miles is a population of over 12 millions, or one-fifth of the population of Great Britain. The greater part of this hinterland lies within the port's economic zone, including the great industrial West Midlands with Birmingham at its centre.

The value of the progressive policy followed by the Port Authority in providing up-to-date dock accommodation has been shown by the steady development of the trade during the present century. Old and well-established trades have been stimulated and new ones fostered. Fresh trade routes have been encouraged by means of an active commercial policy based upon the Port's exceptional distributive power. It is in this respect that the Port of Bristol probably makes its greatest appeal with the advantages of dual rail connection by lines of the Great Western Railway Company and London, Midland and Scottish Railway Company, supplemented by an effective waterway to the Midlands. There is also the further asset of regular coastwise services for goods in transit to and from other ports and a network of roads radiating in every direction. Traders, therefore, have the choice of the several methods of transport in supplying the needs of an area comprising the West of England, the whole of South Wales, the Midlands and a great part of the South of England.

The Port Authority is rendering every possible assistance in the development of new industries in the vicinity of the port and in pursuance of this policy a large area of land has been acquired in close proximity to the Avonmouth Docks. This offers excellent opportunities to manufacturers requiring ready access to sea routes and with the attendant advantages of cheap reception of raw materials and conveyance of manufactured articles, advantages which are further strengthened by the geographical position of the port situated as it is far up the Severn Estuary.

Oil Jetty and Pipe Lines at entrance to Avonmouth Dock

New "W" Shed at Royal Edward Dock, Avonmouth

Port of Bristol Authority—continued

Notwithstanding the already great trade which the Port enjoys, the Port Authority is fully alive to the need of still further trade expansion, and in enlarging and equipping the docks in the manner described, it has displayed an optimism which compels admiration. Bristol certainly appears to have commenced the long climb back to her former eminence among the great ports of the country.

Notable Bristol Port Personalities.

On page 177 are photographs of three gentlemen who, as officials of the Port Authority have rendered valuable service to the Port of Bristol and have made their influence felt in the growth and development of the Port. The centre figure is Mr. R. H. Jones, O.B.E., who has just retired from the general managership; on the left is Mr. F. D. Arney his successor, who took over managerial duties on the 1st October and on the right is Mr. W. P. Wordsworth, B.Sc., A.M.I.C.E., the chief engineer, who has been responsible for the execution of the works described in the foregoing article.

A biographical notice of **Mr. R. H. Jones** was given in the December, 1941, issue.

Mr. F. D. Arney, entered the Port Authority's service in 1914. Appointed Office Manager at the Head Office, in 1933, he has since held the positions of Assistant Secretary, Assistant General Manager and Deputy General Manager prior to being appointed General Manager from 1st October, 1945, on the retirement of Mr. R. H. Jones.

He is a member of the Bristol and Severn Ports Board of the National Dock Labour Corporation and Chairman of the Bristol Port Emergency Committee.

A Member of the Institute of Transport, he is Vice-Chairman of the West of England Section of the Institute.

He served overseas with H.M. Forces in the 1914-18 war.

Publications Received

The **Transactions of the Institution of Civil Engineers of Ireland,** for the Session 1944-5, contains the Presidential Address of Mr. P. J. Raftery, in which he makes a survey of the formation and past history of the Institution, together with several engineering papers and discussions of interest generally, not associated with dock and harbour work.

The **Statements of Accounts, Reports and Statistics** of the **Napier Harbour Board,** New Zealand, cover the war period, 1941-44, and give deferred information on the activities of the port, which included a main construction scheme now virtually completed, about which it is hoped to give details in a later issue.

The Harbour Called Mulberry, published by Pendulum Publications, Ltd., at the price of two shillings, is the script of a talk originally broadcast by the B.B.C. A booklet of 42 pages, it is accompanied by 58 striking photographs of a very informative and interesting character. The treatment of the subject matter in the text is such as to render it attractive orally, and the style is therefore more dramatic than technically instructive. No doubt listeners would find it very entertaining, especially the general public, for whom it was designed.

" It Can Now Be Revealed " is essentially a railway publication, only touching on docks and harbours as a minor sideline. It is " More about British Railways in Peace and War " and has been compiled for the Great Western; London, Midland & Scottish; London & North Eastern; and Southern Railways and the London Passenger Transport Board, being issued by the British Railways Press Office at the price of one shilling. As with preceding publications of this agency, this booklet of 64 pages, with its profuse photographic illustrations, is very attractively produced and provides a most illuminating description of the valuable services rendered by British Railways during the war period. It is impracticable from the great mass of data to select any particular item for mention: the booklet has to be perused in its entirety to give any fair idea of the immense amount of traffic effort involved in the grim struggle which has just been brought to a happy termination.

Tees Conservancy Commission

Appointment of New Chairman

At a meeting of the Tees Conservancy Commission at Middlesbrough on the 14th November, **Mr. George West Byng** was elected Chairman in succession to Sir William Crosthwaite. Mr. Byng was elected as a Commissioner in 1943 and in the following year was appointed to act on the Commission as a representative of the Minister of War Transport.

MR. GEORGE WEST BYNG

He is an Executive Director of Messrs. Dorman, Long & Co., Ltd., and prior to joining the Board of that Company in July, 1942, he had acquired an intimate acquaintance with the heavy and light industries of Great Britain as a Senior Executive in the head office of Barclay's Bank in London. He is also a Barrister-at-Law.

Mr. Byng has been Chairman of the local Development Committee, which has initiated schemes of port development on the Tees, and these are shortly to be submitted to Parliament.

Returning thanks for his election, Mr. Byng said that Tees-side was on the threshold of important developments. " For nearly 100 years," he said, " we have been merely Commissioners. We are seeking much wider powers, including construction of our own docks. Our aim is to provide efficient facilities for imports and exports. The river must be regarded as a natural asset and we are bound to strive to the utmost of our power to explore its many potentialities in the promotion of these schemes."

Khorram Shahr Harbour

It is reported from Bushire, in the Persian Gulf, that considerable improvements have been carried out at the Port of Khorram Shahr during recent years. Seven berths are now available for vessels up to 440-ft. in length, the total length of berth being 3,280-ft. Vessels drawing up to 28-ft. can be berthed alongside at all stages of the tide. In addition, two mooring berths are provided and the holding ground is good. There is ample swinging room for vessels not drawing more than 28-ft. or exceeding 450-ft. in length. Excellent facilities have been provided for the dispatch of vessels, and portable cranes with a maximum load of 10 tons are now installed. In addition, boosters and trucks have enabled as much as 250,000 tons per month to be discharged. The wharf in general is soundly constructed and water is laid on at all berths.

Slipways

By R. R. MINIKIN

The use of slipways for repair work to vessels is limited; generally they are only profitable for smaller vessels up to 1000 tons, above that it is increasingly difficult to work them economically. There are a few exceptions; in localities where the natural ground contours and the good foundation quality of the strata favour cheap construction, and in places where there is an absence of other repair facilities, such as

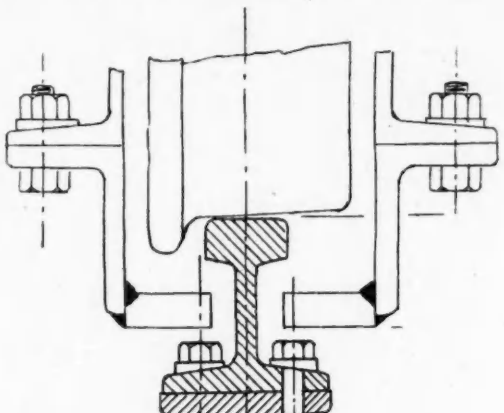


Fig. 1.

dry or floating docks. In very few cases are the slips, from uphaul to downhaul stops, less than 2½ times the length of the vessels for which they are designed. It is found that the most economical and convenient slope is between 1 in 12 and 1 in 15. A steeper slope has the disadvantage of heavy haulage and a shore end too high for convenient work. A lesser slope whilst being less exacting on the haulage makes for a long slip and long haulage wires, thus entailing heavy initial outlay and maintenance. A suitable site for a slip is often difficult to get where it would be most useful and in some cases, where the water depth allows, they have been constructed with the line of the slip making a small angle with the high water line of the shore, instead of more or less perpendicularly across the contours of the beach, which is more usual.

The tidal range is a matter of great importance. The greater the range the more easy is the construction and the greater likelihood of carrying out the whole of the work without the aid of divers. In poor ground of less than ½ ton per square foot safe bearing capacity, it is usually more economical to found on piles: though, as a matter of fact, working slipways on the Severn Estuary taking vessels up to 2000 tons displacement have been entirely constructed without piles on the estuarial silt. In these days, however, the professional practitioners of Civil Engineering have been so impressed with the axioms of Soil Mechanic theories that few would attempt the gamble, howsoever successful such instances in the past have proved to be.

Length of Slipway

The total length of the slip depends upon the maximum length of the vessels using the slip. The approximate length between stops will be:

$$l = 2L + s(d + h) + 20.$$

where L = length of vessel between perpendiculars.

s = horizontal distance for 1 foot rise of slip inclination.

d = draft of vessel at forecastle bulkhead.

h = height from the rail level to the top of blocks.

For example, a vessel of 200-ft. B.P. draft 5-ft. with a slope of rails of 1 in 15 and 2-ft. 6-in. height from rails to top of blocks: $l = 2 \times 200 + 15(5 + 2.5) + 20 = 532.5$-ft.

To this must be added an extension seawards for downhaul extension of 5 to 10 feet for piled supports. Whilst it is common practice to take H.W.O.S.T. as water level for slipping there may be necessity to use the slip for the larger vessels before H.W. In such a case the length of slip must be increased. On poor foundation material piling is often resorted to providing the funds are available, and the return on the capital outlay is assured; generally piling becomes expensive as the point loads on the girders or beams carrying the rails bump up the scantlings of the sections required. Piled slips require considerable maintenance so wherever possible a spread foundation should be used of timber or concrete or a combination of both. Many slips have been constructed on timber grids of substantial scantlings, viz. a bottom layer of 14-in. × 14in. cross baulks on which in the line of the rails 3 No. 12-in. × 12-in. timbers are spiked: on these longitudinals 6-in. × 9-in. cross timbers are laid to carry the rails and pawl racks as shown in fig. 3. Although these timbers tend to deteriorate at mean water level they are easily renewable by tradesmen labour only at moderate cost. The heaviest maintenance cost of many of these slips is to keep the ways clear of estuarial silt. An expedient which has proved effective in waters of high tidal range is to provide flushing basins at the shore end of the slip. These are filled to high tide level and then at or near the time of low water the valves are opened and the water directed in a strong stream to clear the ways and approach channel.

Rail Track

For vessels up to 24 feet beam two lines of rails are ample but for larger vessels four lines of rails are advisable: for the former a gauge of from 10 to 12 feet with pawl racks on the outside of each rail is general practice, but for the latter the two outside rails are usually at 20 to 24 feet centres, with the centre double rails only 20 to 24 inches apart and a heavy pawl rack between them. This disposition of rails and pawl racks has proved most convenient. The pawl racks are usually of cast iron from 4-in. to 7-in. wide with 1-in. projecting teeth at about 6-in. pitch: the pawl being about 12-in. long. The bolt holes for the pawl rack should be placed in line with the projecting teeth so that the pawl will not foul the bolt head or nut. Where it is placed between centre double rails it can be bedded down on a plain concrete base laid between the two supporting beams or bolted to the bearing plate of the rails when laid direct on timber baulks.

Cradle

The design of the cradle is a most important factor in the efficiency and cost of the slip. There are three types: (a) rigid (b) semi-rigid (c) telescopic. Considered from the operational angle the rigid cradle with continuous wheel trains on each rail is the best. There is little mechanical trouble when care is used in maintenance: the load distribution on rails is more or less uniform. The disadvantage is that the wheel trains interfere with the clear access to the vessel's bottom in their vicinity, and the slip must be longer than cases (b) and (c). The semi-rigid cradle is a compromise between (a) and (c). This is effected by dividing the cradle into three or more parts connected together by double chains. Thus with a three-part cradle the middle portion will be two-fifths of length of fully extended cradle,

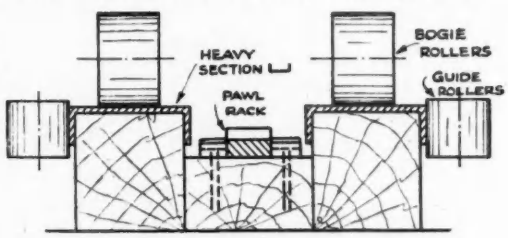


Fig. 2.

the shore end portion and the seaward portion will be each one-fifth length, and the connecting chains will be one-tenth length of fully extended cradle. This disposition will save 20 per cent. of rigid cradle length of slip below first contact, that is in deep water where construction is most expensive. By this arrangement, however, a portion of the wheel trains may be moved out of the way to give access to the bottom of the vessel slipped. To overcome difficulties experienced with the above two types telescopic cradles have been used. These

Slipways—continued

are merely separate bogies, carrying the keel blocks, interconnected by double chains. They are usually supported on three wheels 9-in. to 12-in. diameter on each rail. The outer bogie wheels are flanged and run on B.S.F.B. rails of heavy section, whilst the centre wheels on each side of pawl rack may be flat rollers running on steel joists. Each bogie chassis is about 5 feet long so that if spaced at 15 feet centres it will be readily seen that the telescoped lengths will be but one-third of the rigid cradle length. It will also be appreciated that by disconnecting the chains any bogie can be easily moved to one side to allow clear access to vessel's bottom. The leading bogie should be connected by a rigid M.S. bridle to the uphaul block carriage.

The disadvantage of the collapsible cradle is the concentration of the load in a few points throughout the length, requiring heavy section supporting beams, particularly on piled foundations. A further drawback is the damage caused by the binding of the wheel flanges against the rails. The trouble begins after first contact whilst sueing. Owing to the short wheel base of each bogie the vessel may settle on the leading block at an angle which is not square to the bogie axle, so that on hauling up the wheel flanges are not in line with the rails. The vessel settling on the carriages in this position renders the whole system rigid and high lateral stresses are imposed on the rails and bearers. In actual operations a high-pitched grinding noise signals this occurrence. If there is time to do so the vessel should be refloated and reslipped, care being exercised to sue to line.

To prevent such happenings, the carriages are sometimes fitted, fore and aft of the wheels, with projecting plates bent under the bulb of the rails to serve as guides and to hold carriages to the track as shewn in fig. 1. Where such plates are fitted, fish plates must be omitted from the rails and the holding down bolts of the rails must not project higher than nut height, or they should be inserted as shewn.

It must be conceded that given a good master shipwright the above troubles are not likely to occur.

If the centre rails are of timber it is inadvisable to protect the top surface of timber forming the wheel track by a thin mild steel plate. The tendency is for such plates to curl up at the butts. A more practical solution is to fit a channel section as shewn in fig. 2; the channels may also serve as guide rails if side rollers are fitted to the chassis of the cradle bogies.

Where the ground at the site is poor and under-water work is necessary it will be found that the cheapest in initial outlay and maintenance is to support the rails on mild steel sections spanning pile bents. For light vessels up to 150 tons displacement piles at 10-ft. centres and single 12-in. × 6-in. heavy section R.S.J's beams with cross bracing of 5-in. × 4½-in. R.S.J's will be found serviceable, but for heavier vessels compound girders or those of the crane gantry type should be used. If R.S.J's of too light a section are used there is a tendency to lateral buckling, particularly with collapsible cradles. In any case with a flat gradient collapsible cradles should not be used as the vessel may sue before the cradle is extended. The pile caps to which the steelwork is secured should be of reinforced concrete or mass concrete held in a pre-cast skin. These should not be too generously dimensioned. It will be found that 2-ft. wide in the run of the slip for outside tracks and 3-ft. wide for inside or centre track is quite sufficient for vessels up to 2000 tons. A few typical sections are shewn in fig. 3; (a) shews a suitable cross section of plain concrete walls continuous under tracks with a fabric reinforced floor between rails for vessels of 200 tons displacement and up to 20 feet beam. Two pawl racks are shewn on outside of each rail, which are at 10 feet centres: the rails are 75-lbs. B.S.F.B. type; (b) shews section of a larger slipway of similar design for vessels up to 2000 tons with double centre rail enclosing pawl rack. The rails should be of 112-lbs. per yard and if concrete is not of first class quality (1, 1½, 3) should be provided with welded-on bearing plates under rails; (c) is a cross section of a piled slipway for vessels up to 1100 tons displacement. The piles are of reinforced concrete 12-in. sq. with pile caps (2-ft. × 2-ft. 6-in.) on outer rail and (3-ft. × 3-ft.) on inner rail. The outside girders are of heavy gantry type section and the inner of heavy R.S.J. section cross-braced by 8-in. × 5-in. R.S.J's at 6 feet centres. The pawl rack is carried on a plain concrete bed between centre bearers. Piles are spaced at 10 feet centres under ¾ sue section and below and 8 feet centres on full sue; (d) shows a cross section of the timbered raft type for vessels up to 1500 tons where the ground is of sand and gravel. In all cases the height of the top of rails above high water is governed by the working headroom from the under-side of vessel's bottom to deck or floor between tracks; below high water the rails may be at beach level. The headroom is usually 3-ft. 6-in. minimum.

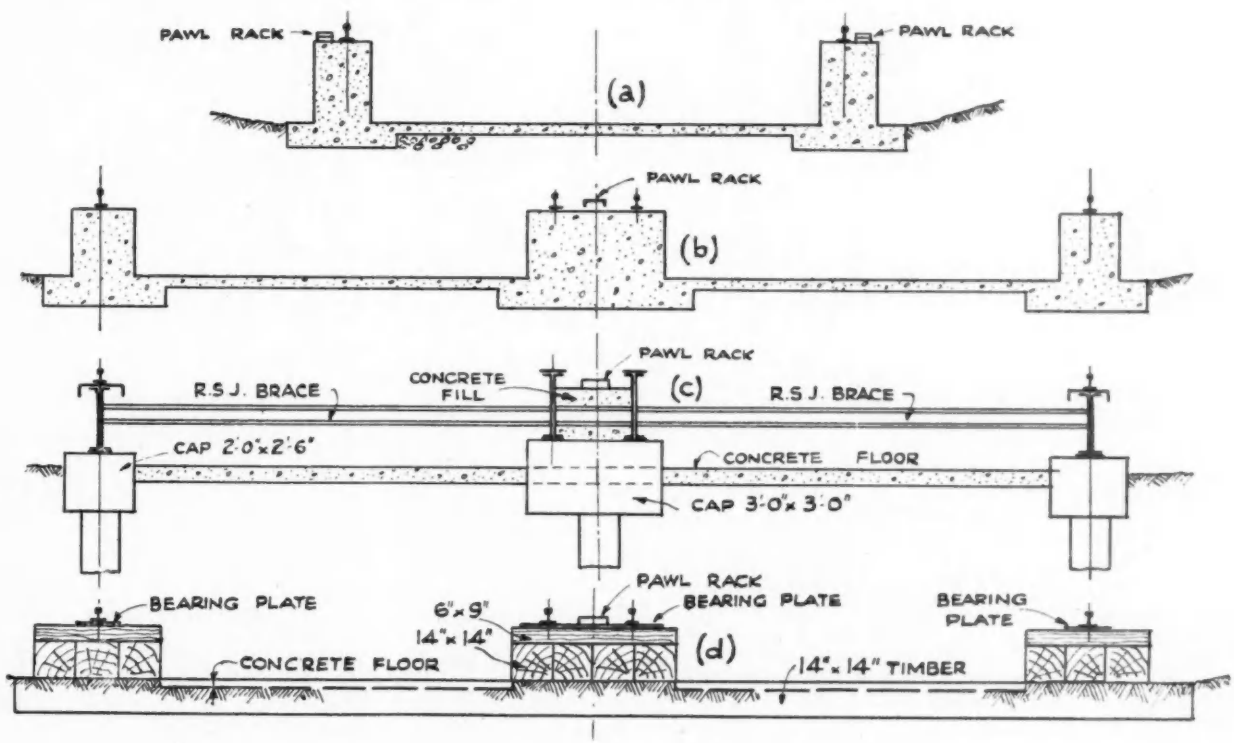


Fig. 3.

Slipways—continued

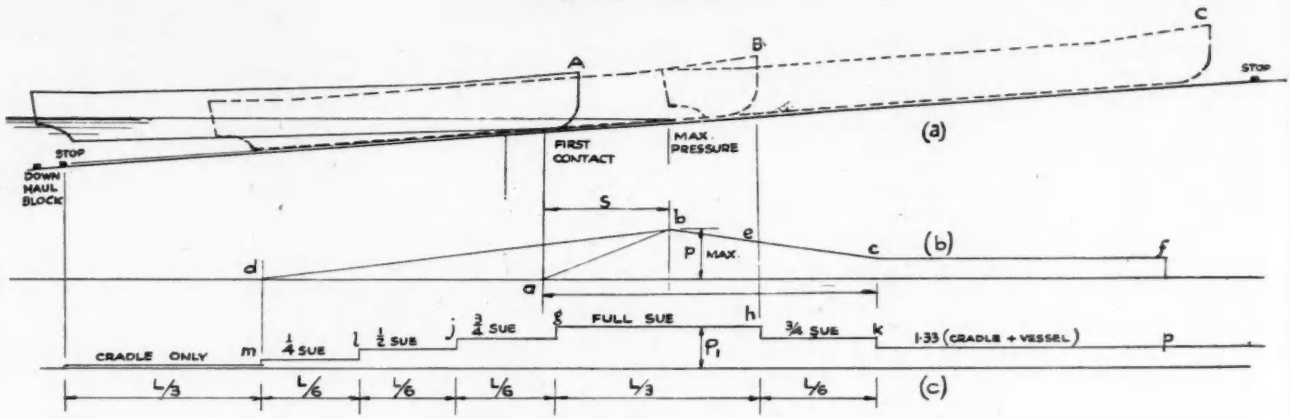


Fig. 4.

Stops should be provided at the bottom or sea end of slip to prevent cradle running off rails and at the top end a single stop for bridle bogie on centre rail to prevent overwinding. A steel bracket with 6-in. × 12-in. timber chocks is sufficient for this purpose.

Haulage

For the uphaul of large ships of up to 2500 tons about 200 H.P. will be required, but for smaller slips a 20 ton winch with warping drums may serve the purpose, depending upon the speed of slipping and the slope. The speed of uphaul varies from 4 to 10 feet per minute. The heavier uphaul winches are of duplex drums for main haul and a smaller drum for downhaul, which can be arranged between the two large drums to allow of paying out the downhaul wire on pulling up and hauling on downhaul whilst paying out from the uphaul drums. The concrete block foundation should not be less than 2 tons per H.P. for small slips to 1 ton per H.P. for the larger slips, deep and secure contact with the ground is essential. The downhaul sheave block at sea end should be anchored to a substantial concrete block, allowing for the loss of weight due to immersion. With a steel girder slip construction a downhaul anchor block is unnecessary. An extension of 6 to 10 feet of the centre girder and one side girder at the sea end, bridged by a substantial channel and provided with attachment to connect sheave block is found suitable.

From the moment of first contact of the vessel with the shore end keel blocks of the lowered cradle, pressure is applied to the rails in proportion to the lost buoyancy of the vessel as it is being drawn out of the water. At the time of contact the vessel A fig. 4 (a) is in floating trim, but as the cradle is uphauled the stern of the vessel settles down and the angle made by the keel of the ship and the line of bearing blocks (keel) becomes less and less. Just before the keel becomes parallel with blocks, or in contact with all blocks throughout the length of the cradle, the maximum pressure is imposed on the fore end block. This is the point of full sue and the pressure on the fore end block at this moment is from $\frac{1}{8}$ to $\frac{1}{7}$ of the vessel's displacement for large and small vessels respectively. This variation depends upon shape of hull and the amount of buoyancy lost in traversing the distance S. The pressure on the tracks under the first bogie in travelling this distance will be represented by the line *a b* in the pressure diagram fig. 4 (b). The after part of the vessel is still waterborne and further movement forward will lessen the pressure on the first block and impose pressure on the other blocks. Therefore when the vessel is in position B and has touched down on all blocks there will be zero pressure at *d*, increasing as the ship mounts the slip, hence a straight line from *d* to *b* will enclose all possible pressures at any point in this length. The line *d-b* is actually a curve, but for practical purposes a straight line is advisable as the state of the tide or weight distribution in vessel may vary considerably. It is therefore of advantage to use for design purposes a diagram of pressure as fig. 4 (c), shewing the load on tracks in fractions of full sue and the distribution in fractions of length of vessel L for which the slip is designed.

It will be appreciated that with the variation in draught of a vessel and the state of the tide, the position of maximum load and load distribution will also vary. As the vessel advances the maximum pressure will decrease as shewn at *e* and *c*, until the ship is entirely in the dry at C. In this position the pressure on the ways is considered as uniformly distributed as *c, f*. Therefore while the pressures shewn in the diagram for any position on the tracks are not simultaneous, the maximum range at any point over the length is represented by the diagram *m, l, j, g, h, k, p*.

It is the practice to assume that the load P at any point is carried equally on all tracks; for example on a 4-rail slip P/3 will be carried by each of the outside rails and the remaining third by the combined centre rails. At the shore end of slip in the dry the displacement weight of vessel + 33 per cent., is assumed to be carried uniformly throughout the length of cradle. The weight of the cradle is taken as the dry weight throughout.

Australian Port Notes

(From a Correspondent)

The Commonwealth Harbours Commission has arranged to visit Western Australia shortly to see what can be done to relieve the congestion of shipping at Fremantle. The harbours of Bunbury, Albany and Esperance are scarcely used to-day, and endeavours are being made to have these ports utilised more fully. Accommodation at the Fremantle wharves is restricted, and it is very doubtful if conditions there can be improved. Delays in berthing are at times considerable, and local trade is now so adversely affected that it is considered to be greatly to the State's economical detriment. Albany claims that much of the shipping coming from the East steams right past its very door, while Esperance claims to be the logical inlet for the Goldfields areas. It is hoped that once the Commission has inspected these harbours, something may be done to put them to greater use.

The War Cabinet has approved of £97,500 being appropriated for port equipment to ensure an efficient operation of the fork lift truck-pallet system of loading and discharging ships. Equipment will include tow motors, light trailers, trams, gravity rollers and trays, and sling legs for pallet cargo. All equipment will be operated as a single pool to ensure maximum co-ordination. The Munitions Department will carry out a local production programme for fork lift trucks, for which satisfactory specifications have been agreed upon, and for which no production difficulties are forseen.

Wharf pillage continues to be rife in all States. Extra police precautions are being taken, but losses are still heavy. Cotton piece goods, sheeting and precision tools are disappearing by case lots, and recently no less than 20 bales of cotton piece goods, valued at £8,000, disappeared from one vessel. There have been numerous prosecutions, in some cases these have been of the men who were set to watch cargoes. Endeavours are now being made to penalise culprits, not only through the courts, but by ceasing to employ them on such work. Unfortunately, at the moment, no sooner does a convicted man serve his prison sentence, than he is back once more on the job. It is hoped that unions may co-operate in this matter.

Notes of the Month

Proposed New Piers in Scottish Waters

The Argyll County Council has appointed a Sub-Committee to interview the Scottish Home Department about certain proposals for new landing piers at Craignure, the Sound of Mull and the Island of Colonsay.

Institution of Mechanical Engineers.

The Presidential Address to members of the Institution of Mechanical Engineers of the new President, Professor Andrew Robertson was delivered at the Institution on October 19th. It was largely concerned with education and educational work.

New Harbour Works Company

A new Company, the Netherlands Harbour Works Company (London), Ltd., has been formed with a capital of £10,000 to engage in the construction and equipment of harbour works of all kinds, including moles, breakwaters, piers, wharves, docks, quays, dams, canals, railways, tramways, roads, etc.

Contemplated Developments at Colombo

Plans have been prepared and are expected to be put into operation shortly for improvements at the Port of Colombo, estimated to cost about £1,875,000. They include the construction of an oil dock and several additional berths for shipping, improvements of existing bunkering jetties, warehouses and coaling storage sites; also an extensive housing scheme for port labour.

War-time Improvements at the Port of Durban

The *Natal Mercury*, of 18th August, gives some interesting particulars of works which have been carried out during the war years in the Port of Durban at a cost of £4,500,000. It states that to-day there exists a Naval Base capable of accommodating anything from a submarine to a battleship, together with new deep-water berths which can receive at least seven large liners. Large cargo sheds are in course of construction.

Resignation of Harbour Board Chairman

Mr. H. A. Short, M.C., Chairman of the Southampton Harbour Board since April, 1944, and a member of the Board since February, 1942, has resigned his connection with the Board on being appointed Deputy Traffic Manager of the Southern Railway Company. The change takes place in consequence of the return of Mr. R. P. Biddle, C.B.E., to his former position as Docks and Marine Manager at Southampton. The Southampton Harbour Board have placed on record their appreciation of the efficient and courteous manner in which Mr. Short carried out the duties of his office during a momentous period in the history of the port.

Port Commission Appointments in Scotland.

At a meeting of the Dundee Harbour Trust on November 21st, **Mr. H. Giles Walker was** re-elected chairman for the fourteenth time. In the course of his speech thanking members, he said: "If the present regime of progress and enlightenment manages to survive for another year I expect we will find our jobs gone and the affairs of the harbour carried on much more efficiently from Whitehall."

Following the resignation through ill-health of Colonel William Mellis from the Aberdeen Harbour Board, his son, Mr. William R. S. Mellis, of George Mellis & Son, Ltd., has been appointed a member. This appointment continues a period of 39 years' service to the Harbour Board by members of this firm, Col. Mellis having served for 19 years and succeeded Mr. John Ross, of the same firm, who served for 20 years.

At Leith, Councillor J. J. Robertson, M.P., has tendered his resignation to the Dock Commission on being elected to Parliament. Mr. James MacDonald Smith, convenor of the Grain Elevator Committee on the same Commission, has also resigned his appointment.

Lengthy Harbour Service Record.

Mr. George Emslie, General Foreman in the Works Department of Aberdeen Harbour Commissioners, has retired after forty-six years' service. In 1944, he was decorated with the B.E.M., for his services to the Admiralty. On his retirement Mr. Emslie was presented with a wallet of notes by workmates.

Institution of Civil Engineers: Maritime Division

At a meeting of the Maritime Engineering Division of the Institution of Civil Engineers in London, on December 11th, a Paper will be read on "Cement Gun Repairs to Maritime Reinforced - Concrete Structures, with special reference to the Town Quay, Southampton," by Mr. J. P. M. Pennell. Meetings take place at the Institution Headquarters at 5.30 p.m.

Great Indian Tidal Wave

The disclosure has been made of a tidal wave 200 miles long, which recently invaded the Coromandel Coast in the province of Madras, sweeping inland from the sea for a distance of from 3 to 5 miles. The damage done is estimated in tens of millions of rupees. The wave wrecked thousands of acres of paddy fields and the consequent loss of rice crops threatens famine over a wide region.

Fairway Clearance at St. John's.

The entrance fairway to the harbour of St. John's, Newfoundland, has been cleared of the rocks which previously endangered the passage of ships with a draught exceeding 28-ft. The fairway has now been deepened to 40-ft. by the removal of the Merlin and Ruby Rocks and other obstructions. The work was carried out by the MacNamara Construction Company and has taken twelve months to complete.

Reclamation Project at Sunderland

The River Wear Commissioners propose, subject to Government consent, to proceed with a scheme, forming part of their post-war development programme, for the reclamation of four acres of foreshore at the old South Outlet to the South Docks at the port. The work comprises the construction of a steel sheet-piled retaining wall at a cost of between £13,000 and £14,000, with hard rubble filling behind. Operations are expected to be spread over two or three years.

British Nautical Instruments Association.

At the 27th annual general meeting of the British Nautical Instrument Trade Association held at York on October 18th, the President, Mr. A. E. Cater, referred to the special meeting of all the members of the Association which was devoted to the problem of post-war Chart supply and Chart correction. A tentative scheme was submitted by the Chart Convener, Mr. Francis Huges, which aimed at considerable improvement over pre-war conditions. The Association was pleased to find that shipowners were showing much more interest in the establishment of a commercial Chart correction system in the United Kingdom than before. The President and the Vice-President (Mr. Francis Hughes) were re-elected for a third year of office.

Port Health Amendment Regulations.

The Ministry of Health has issued a series of amended Port Health Regulations made under Section 143 of the Public Health Act, 1936, which came into operation on 1st December. They are made primarily with a view to giving effect to the provisions of the International Sanitary Convention, 1944, so far as these affect the Port Sanitary Regulations, 1943. At the same time, opportunity has been taken to introduce certain other amendments of the Port Sanitary Regulations in question, which experience has shown to be desirable. On examination of the new Regulations it will, the Minister of Health thinks, be found that they involve no basic change in the present general procedure of Port Health and Riparian Authorities under the Regulations of 1933.

Oil Fuel Storage Tanks and Pipe Lines

Design of Modern Port Installations

By STANLEY C. BAILEY, Assoc.M.Inst.C.E., F.G.S.

General

IN most ports of any importance, and near the banks of navigable rivers, there are usually oil fuel installations consisting of groups of tanks, constructed of steel or reinforced concrete, with pipe lines to a wharf or jetty, alongside which the oil tankers or vessels carrying the oil may be moored and the oil pumped by the ship's pumps into the shore tanks, while the ships that require oil for fuel purposes can have their tanks filled at all states of the tide. This is important to save harbour dues and delay.

Tanks constructed of steel, with either flat, slightly domed, or conical roofs, vary in size from about 50-ft. diam. and 20-ft. high, holding 980 tons of oil, to 117-ft. diam. and 41-ft. 10-in. high, containing 11,100 tons.

Reinforced concrete tanks standing above ground level have also been constructed, some in California being so much as 601-ft. in diameter and 20-ft. high, with a capacity of about 142,000 tons. Tanks, where possible, should be situated on higher ground than that of the wharf, so that a gravity flow of oil may be obtained, in case the pumps in the shore pump-house that deliver the oil to vessels fail or are under repair.

Oil reservoirs with mass concrete, or reinforced concrete walls, either wholly or partially sunk in the ground, and square or rectangular in plan, have been constructed to contain so much as 250,000 tons of oil; when tunneled in rock, the floor, sides and floor are lined with concrete not less than 6 inches thick in the proportions of 1 : 1½ : 3.

The roofs of steel tanks consist of radial steel trusses, sometimes supported at the centre by a cast iron column, bearing on the floor of the tank, the roof covering being 1/8-in. to 3/16-in. thickness of sheet steel, galvanised or painted. In Russia and in the U.S. America, timber is much used for the roof work, the beams and purlins being supported by numerous vertical timber posts fixed to the floor of the tank, while the roof covering consists of creosoted tongued and grooved boarding ¾-in. to 1-in. thick sheeted with tarred felt.

In some hot climates, steel roof sheets on flat roofs are covered with 1 inch of asphalt and bitumen, and the roof is kept flooded with 4 inches of water, contained by an angle iron kerb, the water is pumped up through a pipe, the overflow being allowed to trickle down the circumference of the tank to a channel, from which it flows into the pump sump. This is done to keep the tank and oil cool.

Reinforced concrete tanks above ground may have steel roof trusses with steel sheeting, or reinforced concrete roof frames with 3-in. of reinforced concrete covering, coated on the outside with bitumen. In the U.S.A., some of these tanks have timber roofs.

Underground oil fuel reservoirs have reinforced concrete roofs supported by numerous brick or concrete piers. The roofs have a slight rise for surface water drainage purposes, and are covered with about 1 inch of asphalt and bitumen and from 1-ft. 6-in. to 2-ft. of earth, sown with grass seeds or planted with shrubs, and generally made to resemble the surrounding country. The oil fuel pipes may be either of cast iron or mild steel tubing with either flanged, screwed, or spigot and socket joints, but preferably with screwed or flanged joints. They are usually laid on the ground to save the cost of trenching, and so that they may be more readily examined for leakage and to prevent surface water from percolating through a leaking joint into the pipe, as it is very important that no water should get mixed with the oil. In some installations where the shore pumps deliver into the tanks and also discharge from them, the pipes are conveyed overhead, being supported on timber posts or steel stanchions, the pipes entering the tanks near the top are turned down inside to about 1-ft. from the floor; but in most cases the pipe connections are on the side or periphery of the tank near the bottom.

The valves used are generally of the screw-down sluice valve type, having double gun-metal faces, and indicators showing when they are open and closed. This type offers the least resistance to the flow of oil. On wharves the pipes are usually laid in concrete or brick lined trenches, with pits for the valves and outlets at intervals as required, the trenches being covered with steel or cast iron plates.

On jetties and piers the pipes are laid either on top or slung underneath the deck with the valves and outlets so arranged on the deck that " tankers " or other vessels may connect to the oil main by means of flexible armoured hose pipes.

The oil is pumped from the " tanker " using its own pumps, either direct into the shore tanks, or should the distance between the ship and the tanks be too far, or the height to the tanks too much for the pumps, then the oil is forced into a small cylindrical closed tank or receiver with an air vessel in a shore pump house, situated on the pipe line between the ship and the tanks; the shore pumps deliver to the tanks, but in most installations the oil is pumped direct from the ship's pumps to the tanks, and the shore pumps are only used to deliver the oil to vessels, or to transfer it from one tank to another, as delivery by gravitation is a slow process, although it is adopted in some installations, especially in hot climates and when the oil is of low viscosity. In some cases an oil strainer or filter with a bye-pass pipe and valves is interposed on the main between the pump house and the delivery pipe to the jetty or wharf.

In cases where there are groups of tanks containing oils of different quality and specific gravity, it is sometimes necessary to mix the oil in one tank with that in another, therefore the connecting pipes and valves to them and the main pipe to the pump house must be so arranged that this can be done.

Relative Merits of Large and Small Tanks

With reference to the relative merits of installing a number of large tanks, in lieu of a greater number of small ones having an equal total capacity, this depends upon the ground area available, financial considerations, and the possibility of a tank being set on fire by lightning, with greater loss of oil in the large ones—this has occurred in several instances. There is also the question of the origin of the oil, for if shiploads of it arrive from different countries, a larger number of small tanks will be required to keep the consignments separate, and pipe lines will be longer in the case of the small ones. The cost of the foundations is also an important factor when deciding on the size of the tanks. As regards the relative costs, a steel tank 100-ft. diam. by 36-ft. 6-in. high, containing 7,068 tons of oil at 40 cub. ft. per ton, laid on a 2-ft. thick concrete raft 103-ft. diam., sunk 1-ft. 6-in. in the ground and covered with 1-in. thick creosoted boarding, would weigh: for steel tank, 250 tons; foundation, 1,052.7 tons; and oil, 7,068 tons—a total of 8,370.7 tons, or 1.05 tons per sq. ft. on the ground—and would cost at pre-war prices about £10,520, or £1.48 per ton of oil stored. Three smaller tanks, each 70-ft. diam. by 25-ft. high, holding 2,356 tons of oil, or a total of 7,068 tons, if constructed on foundations 73-ft. diam., and otherwise similar to that of the large tank, the weights will be for one tank, 77 tons; foundation, 529 tons; and oil, 2,356 tons—a total of 2,962 tons, or 0.707 tons per sq. ft. The cost would be about £3,680 each, or a total of £11,040, equivalent to £1.54 per ton of oil stored.

Oil Fuel Storage Tanks and Pipe Lines—continued

Construction of Steel Tanks

Figs. 1 and 2 are sketches of the elevation and half plan respectively of a typical cylindrical, mild steel, oil fuel tank; it is 100-ft. diam. and 36-ft. 6-in. high, with an oil depth of 36-ft. and holding 7,068 tons of oil at 40 cub. ft. per ton, or 7,440 tons at 38 cub. ft. per ton. The weight of the tank is about 250 tons, or 1.953 lbs. per cub. ft. up to 36-ft. 6-in. depth. If tested with salt water 36-ft. deep, the weight of water will amount to 8,078.4 tons. The steel-work of some tanks of lighter construction weighs from 1.536 to 1.573 and 1.755 lbs. per cub. ft. total capacity, the the average weight of a number of tanks being 1.704 lbs. cub. ft.

The sketches are self-explanatory, all joints in the plating are lapped, and the corners of the inside plates are thinned down at the joints; the roof is covered with $\frac{1}{8}$-in. thick painted or galvanised steel sheets, having lapped joints with 5/16-in. diam. rivets $1\frac{1}{4}$-in. pitch; the floor plates are 10/20-in. thick with lapped joints and $\frac{3}{4}$-in. diam. rivets $2\frac{1}{4}$-in. pitch.

The pressure on the circumferential plates in tons will be:

$$P = \frac{D.R.W.}{2240}$$

where D = Depth of fluid in ft., R = Radius of tank in ft., and W = Weight of fluid in lbs. per cub. ft.

Therefore for 36-ft. depth of oil (Sp. Gr. 0.94) weighing 58.7 lbs. cub. ft., the pressure will be 47.1 tons, and for sea water at 64 lbs. cub. ft. it will amount to 51.4 tons, as shown in the diagram (Fig. 3), from which the pressure at any depth may readily be obtained. The pressure on the lower 1-ft. depth of the plating 15/20-in. thick due to a head of 35-ft. 6-in. of oil = 46.5 tons, the sectional area of the plate = 12-in. x 15/20-in. = 9 sq. inches, and deducting four rivet holes 1 1/16-in. x 15/20-in. = 3.1 sq. inches; the net plate area = 5.9 sq. inches, and $\frac{5.9}{46.5}$ = 7.8 tons per sq. inch, stress on the plating, and the safe stress may be taken at 8 tons per sq. inch, as the load is a static one. There are three vertical rows of 1-in. diam. rivets at 3-in. pitch or 11 rivets per ft. depth at the ends of the plates, and the single shear area of the rivets is 11 x 0.785 = 8.635 sq. inches . . $\frac{46.5}{8.635}$ = 5.38 tons per sq. inch, and the safe shear is 5.6 tons sq. in.

The bearing area = 11 x 1-in. x 15/20-in. = 8.25 sq. inches and $\frac{46.5}{8.25}$ = 5.63 tons sq. in. on rivets, while the safe bearing stress is from 8 to 10 tons sq. inch.

There will be an initial stress on the rivets, due to cooling of about 1 ton per sq. inch. Slip of joints takes place when the shear on the rivets exceeds 7.5 ton sq. in. for plates up to 0.6-in. thick; 6.2 tons sq. in. for $\frac{3}{4}$-in. plates; and 5 tons sq. in. for 1-in. plates. This friction between the plates reduces the tension on the rivets. There will be an increased stress on the plates and rivets when the tank is tested with water, but as this is only temporary it may be neglected.

Weight of Tank

With regard to the weight of a tank 100-ft. diam. x 36-ft. 6-in. high, this will be as follows, viz.: floor plates, 73.84 tons; circumferential plates, 131.33 tons; roof, 42.4 tons; swing arm winch, manhole covers, ladders and gangway, 2.43 tons—a total of 250 tons. The load on the circumference from the roof will be $\frac{42.4}{314}$ = 0.135 tons per lin. ft.

The roof trusses weigh 6.73 lbs. per sq. ft. and including the sheeting and gangway, 12 lbs. per sq. ft., and, if snow is added at 5 lbs. per sq. ft., the additional weight will be 17.5 tons, or a total of 59.9 tons = 0.19 tons per lin. ft.

When estimating the weight of a steel tank 1.6% should be added to the weight of the plating to allow for end laps. The width of the plating should not exceed 5-ft. to enable the long jaws of the pneumatic rivetter to close the rivets. An extra 1.7% should be added to the gross weight of the plates for rivet heads and snap ends; the weight of these per 100 is as follows, viz.: 1-in. diam. rivets, 27 lbs.; $\frac{7}{8}$-in., 22 lbs.; $\frac{3}{4}$-in., 15 lbs.; and $\frac{5}{8}$-in., 9 lbs.

The tank plating is rivetted throughout, the rivets being preferably closed by a pneumatic rivetter at a pressure of 90 lbs. per sq. inch. The plates of steel tanks are usually in lengths of from 12 to 16 or 20 ft.

Joints in Plates

There are five methods in use for the joining of steel tank plates, viz.:—

(1) By cutting the plates to the net dimensions and placing each tier, one directly over the other, with outside flush surfaces, butting all joints, and putting outside cover plates at each joint (as shown by Fig. 4 A). This increases the weight of plates by about 15 per cent. and doubles the amount of rivetting to be done.

(2) By building inside and outside strakes alternately in each tier, lapping horizontal joints, and fixing outside cover plates to vertical ones, this increases the weight of plating by about 5 per cent. and doubles the rivetting in vertical joints.

(3) By forming inside and outside strakes alternately in each tier, and using single laps at all joints, the outside plates lapping at each end over the inside ones (as shown in Fig. 4 B), and at the corners where the plates join, the inside plate is thinned down by a planing machine or by hot forging (Fig. 4 C), this is the most usual method. If the corners of the plates are not thinned down, then a liner (L) or filling piece of metal must be inserted to fill the space between the plates (as shown in Figs. 4 B and D).
The thinning of the plates is not suitable for water tanks, because they are liable to corrode rapidly, and liners should preferably be used.

(4) By constructing inside and outside strakes alternately in each tier, using single laps at all joints, but the plates in each strake lap on the outside at one end, and on the inside at the other (as shown in Fig. 4 D) the inside ends being thinned down at the corners.

(5) By arranging the plates with butt joints, as described in method (No. 1), the edges of the plates being planed to a bevel on each side filled with metal and fused together by oxy-acetylene or electric welding; the latter makes the strongest joint.

This method is generally only used for gasoline and petrol tanks, but some oil fuel tanks in the U.S.A., 117-ft. diam. and 41-ft. 10-in. high, have 3/16-in. roof sheeting and $\frac{1}{4}$-in. floor plates electrically welded, and out of 19 tanks erected one failed, the break starting at the electric welded L steel at the bottom, the lower tier of peripheral plates $\frac{5}{8}$-in. thick cracked, the oil caught fire and set alight a second tank. At the time of the failure there was 36 degrees of frost, and the contraction due to this may have hastened the break. All tank plating should break joint, and the edges of the plates should be planed to a slight bevel for caulking purposes.

Expansion of Tank Plating

With reference to the expansion of the plating in tanks, the co-efficient for the expansion of steel is 0.00000672 for each degree (Fahrenheit) rise of temperature, and, on the 50-ft. radius of a 100-ft. diam. tank, with a rise of temperature of from 0° F. to 120° F., the expansion of the roof sheets in inches will be 50 x 12 x 120 x 0.00000672 = 0.48 inches, and on the 314 ft. of the circumferential plates it will amount to 3 inches, producing a slight increase in the diameter.

Fittings to Tanks

The fittings required for tanks include manholes at least 24 inches diam. on the roof and near the floor level on the circum-

Oil Fuel Storage Tanks and Pipe Lines—continued

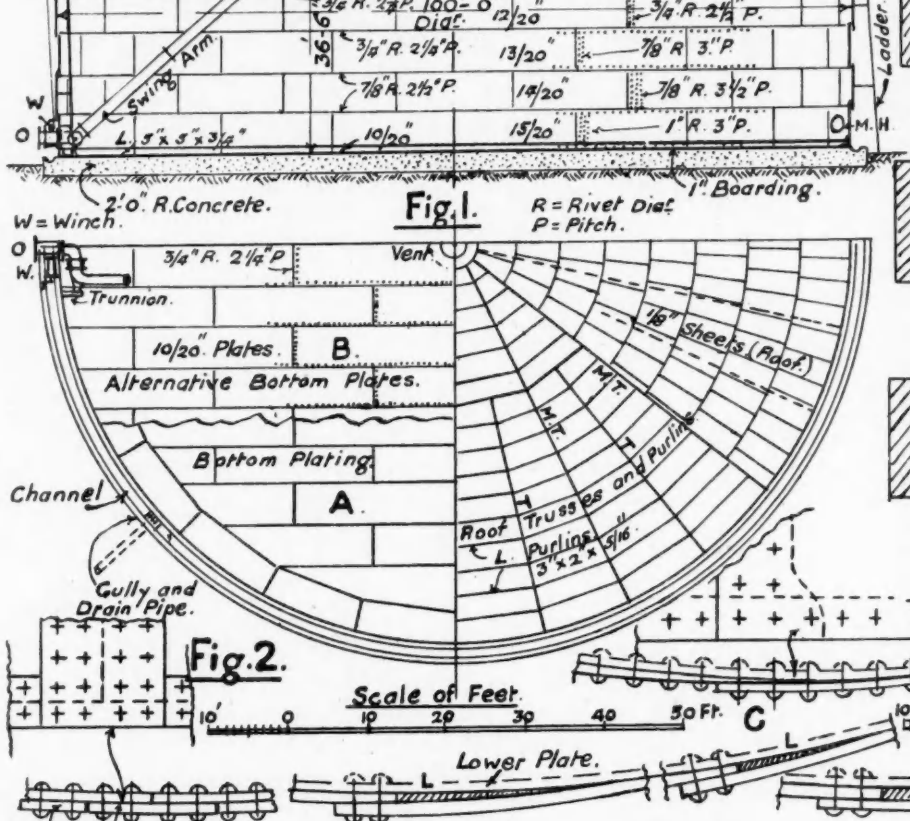


Fig. 1.

Fig. 2.

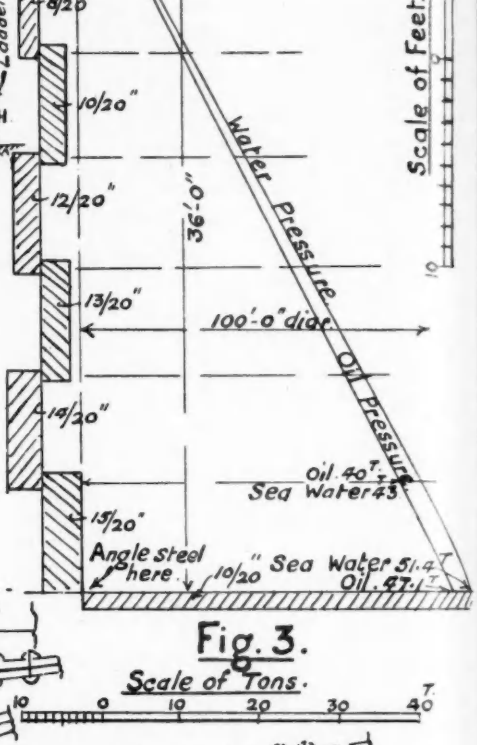
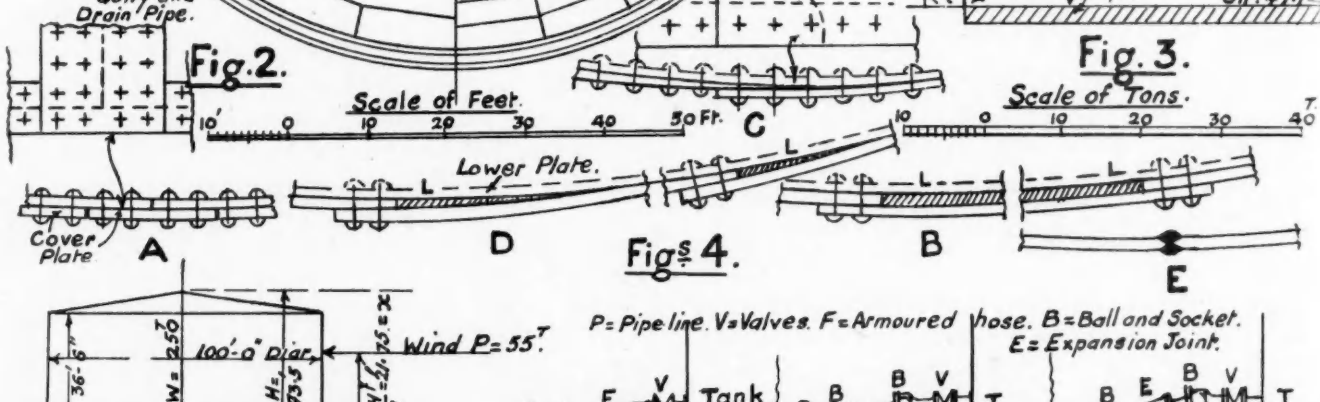


Fig. 3.



Figs 4.

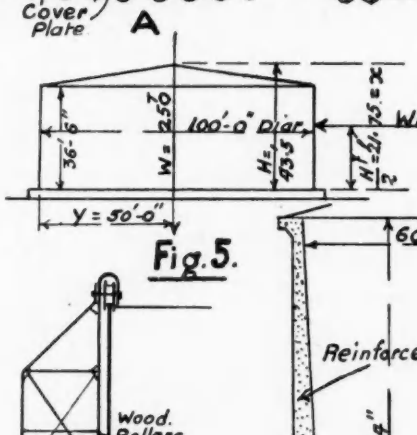


Fig. 5.

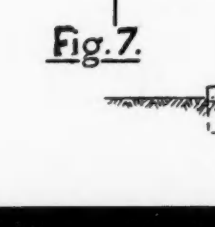


Fig. 7.

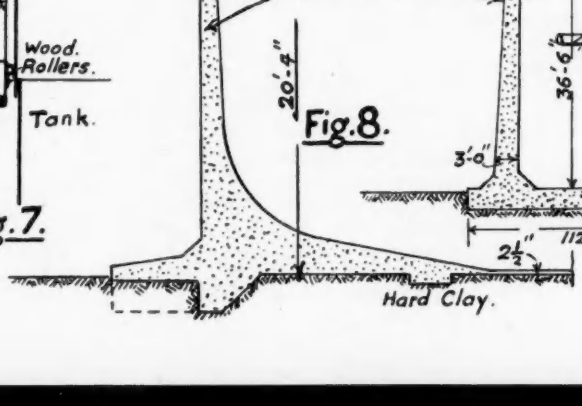
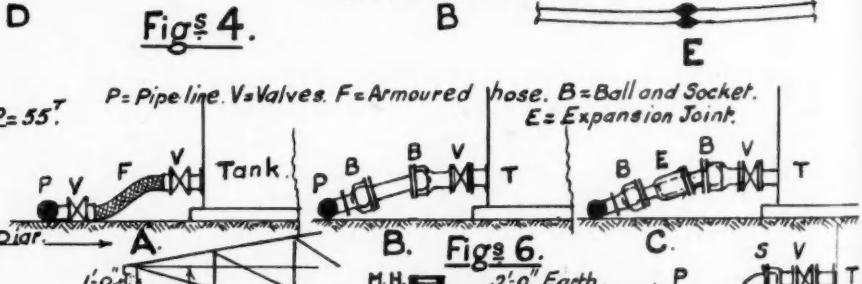


Fig. 8.



Figs 6.

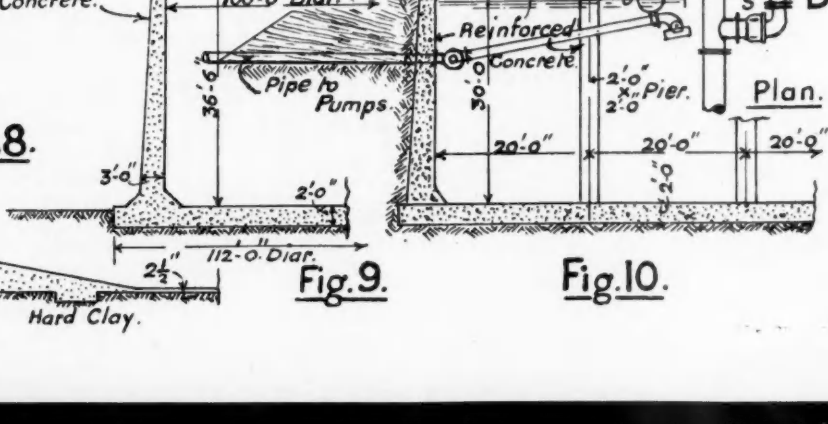


Fig. 9.

Fig. 10.

Oil Fuel Storage Tanks and Pipe Lines—continued

ference, inside and outside ladders, two gauges with stop cocks, a small hand winch for operating the swing arm, a valve near the floor to drain off any water that may accumulate from roof leaks. A ventilator at the apex of the roof and a gangway from the periphery leading to it. On the outside top kerb of the tank, a flat iron rail should be provided round the circumference on which grooved rollers with suspension bars or hooks can travel, and from which a cradle may be suspended for caulking and painting purposes. The swing arm is formed of ⅜-in. thick mild steel tubing and is pivoted to the main pipe connection at O (Figs. 1 and 2) by a swivel pipe and trunnion joint. The upper end is fitted with a cast iron bell mouth and strainer; the swing arm is operated by a wire rope passing over a pulley on the top edge of the tank and down to a hand winch (W) outside the tank. In some cases the upper end of the swing arm is fitted with a cylindrical float made of sheet iron with welded joints and is automatic in action. Lightning conductors are not fixed to tanks, but in reinforced concrete ones the steelwork should be earthed.

Snow and Wind Pressure

With regard to snow loads and wind pressure, the weight of snow of various densities in lbs. per cub. ft. is as follows, viz.: Snow as it falls, 4½ lbs.; compact snow, 10 to 14 lbs.; that of the consistency of a snowball, 15 to 19 lbs.; and snow frozen for a week, 33 to 35.5 lbs.; while the weight of ice at 37 lbs. per cub. ft. is 4.73 lbs. per sq. ft. per 1 inch thickness—so that in Northern climates a weight of at least 5 lbs. per sq. ft. should be provided for on roofs, especially as those over tanks are more or less flat, and the snow will not readily slide off, but freezes to the sheeting. In Canada a weight of 10 lbs. per sq. ft. is allowed for. The wind pressure on a flat surface, assuming a velocity of 120 miles per hour, will be equal to $P=0.00255\ V^2$, by one formula, while in another $P=0.00322\ V^2$, where P = pressure in lbs. per sq. ft. and V = wind velocity in miles per hour. Assuming the higher value, then $P=0.00322 \times 120^2=46.36$ lbs., say, 46 lbs. sq. ft.

The total area exposed to the wind, including the roof of a tank 100-ft. diam. by 36-ft. 6-in. high, is about 4,000 sq. ft., and 4,000 x 46 x 0.67 = 123,280 lbs., or 55 tons. In the U.S.A. the pressure on a cylindrical surface is taken at P x 0.7 in lieu of 0.67. If the tank is empty the moments will be as shown in Fig. 5. Moment of tank = W.Y. = 250 tons x 50-ft. = 12,500 ft. tons. Moment of wind = P.X. = 55 tons x 21.75 ft. = 1196.25 ft. tons, giving a factor of safety of 10.4 against overturning.

With reference to the possibility of an empty tank being forced by the wind off a concrete or timber platform, the co-efficient of friction for steel sliding on concrete is 0.60, and on sawn pinewood it is 0.64; the values given in some text books are much less, being 0.24 and 0.16 respectively, but are for very smooth surfaces. The total wind pressure required to slide the tank off concrete will therefore be 250 tons x 0.6 = 150 tons, and the wind pressure is 55 tons, giving a factor of safety of 2.72 against sliding.

Painting Steel Oil Tanks

The steelwork of oil tanks is usually given a coat of boiled linseed oil before leaving the works of the contractor, and the interiors of the tanks are not as a rule painted, with the exceptions of the roof trusses and sheeting. If the sheeting is galvanised, it may also be painted after a coat of diluted muriatic acid has been applied. The exterior of the tank, the roof trusses and purlins should be given a priming coat of red lead and two coats of oil colour, while the underside of the floor plates should have two coats of hot tar, neutralised with lime, applied before lowering the bottom on its foundation. The steel tanks in ships are sometimes coated inside with a paint consisting of pitch and carbon bisulphide. In hot, sunny climates, tanks are painted either white, cream or pale grey, and in cold, sunless latitudes, either black, dark brown or dark red.

From experiments that have been made in the U.S.A., the evaporation from tanks painted white is from 1 to 1½ per cent. less than from those painted red, and is 2½ per cent. less than in those painted black. Glossy surfaces are less absorptive to heat than those with a flat surface, while the rise of temperature in a tank painted black is 140 per cent. greater than in one painted white.

The percentage of light reflected by painted surfaces is for flat white 80 and flat black 1, while that for various colours is as follows, viz.: flat ivory, 76; flat buff, 59; flat tan, 37; enamel pink, 51; enamel sky blue, 31; enamel red, 27; enamel grass green, 10; flat orange, 55; yellow, 40; light green, 10; dark green, 46; light blue, 6; dark blue, 30; brown, 15; and chocolate, 4.

Foundations for Steel Tanks

As many steel and reinforced concrete oil fuel tanks are situated on alluvial soil consisting of a mixture of sand, gravel, vegetable earth and clay, there may be some difficulty in providing a stable as well as an economical foundation, for should unequal settlement occur it may be serious, as the tanks will not be vertical and will not hold the full quantity of oil; they cannot be gauged for contents without the use of dipping rods in roof manholes, and the connecting pipes to the mains may be broken. The chief disadvantage of using concrete raft foundations without piling on alluvial soils is that the soils become saturated with water in wet weather, and during frosts will expand and rise, and in hot dry weather contract and sink.

There are several ways of dealing with such soils, viz.: (1) By supporting a concrete platform 9 to 12 inches thick on piles. (2) By forming a ring of steel interlocked sheet piling from 20 to 30 feet deep round the concrete raft carrying the tank to prevent the ground spreading laterally. (3) By constructing a raft of reinforced concrete 2-ft. thick of larger diameter than that of the tank. (4) By driving perforated steel tubes from 10 to 20 feet into sand and gravel soils and forcing in liquid cement grout at 90 lbs. per sq. in. pressure or more, thus converting the subsoil into a cemented agglomerate. (5) By supporting the bottom kerb of the tank on creosoted timber or reinforced concrete sheet piling 20-ft. deep. (6) By wetting and consolidating the ground with a 10-ton power driven roller.

Layers of brushwood and fascines should not be used, as they will decay in time and cause serious settlement, which cannot easily be remedied.

Should the tanks be founded on rock, the surface must be levelled and cleaned, holes filled with concrete, and a layer of concrete a few inches thick spread over the surface on which 1-in. thickness of redwood boarding saturated with 8 to 10 lbs. of creosote can be laid. In some cases a layer of sand 2 to 3 inches thick is spread over a levelled rock surface or on the concrete, in lieu of timber planks. If the foundation for a tank 100-ft. diam. x 36-ft. 6-in. high, full of oil (Sp. Gr. 0.94), at 38 cub. ft. per ton, consists of 1-in. boarding laid on 12-in. of concrete carried on piles 5-ft. apart each way, the total loads will be as follows, viz.: Tank, 250 tons; oil, 7,440; boarding, 12; and concrete, 520—a total of 8,222 tons—and on an area of 8,328 sq. ft. for 103-ft. diam., the load will be 0.98 tons per sq. ft., and, when being tested with sea water, it will be 1.06 tons per sq. ft., and the loads on each pile (exclusive of the pile weight) will be 24.5 and 26.5 tons respectively. The piles required will number 345, but if instead of this a ring of 12-in. sq. sheet piles is constructed under the bottom kerb of the tank, then 314 piles will be necessary.

If a circular retaining ring of interlocked steel sheet piles is formed round the tank, they should not be too severely driven or the joints may burst open and the piles will bend outwards at the points. The maximum tensile strength of such piles weighing about 43 lbs. per sq. foot various from 8,320 to 10,900 lbs. per inch depth of joint.

If in lieu of piling a reinforced concrete raft is built 110-ft. square x 2-ft. thick and sunk 1-ft. 6-in. in the ground for the size of tank under consideration, the total weight will be 9,214 tons when loaded with oil, or 0.76 tons per sq. ft.

To provide against tank settlement on unstable ground, special joints are interposed between the main oil pipes and their connections to the tanks; they generally consist of either flexible armoured hose, swivel joints, ball and socket joints, or inclined pipes with swivels and expansion joints (as shown in Figs. 6, A, B, C, D).

Oil Fuel Storage Tanks and Pipe Lines—continued

Erection of Steel Tanks

In the erection of steel tanks, the bottom angle steel kerb is first laid on wood blocks about 3-ft. high and rivetted up with "L" covers at the joints, the bottom plating, also bearing on blocks, is then constructed, with a camber of about 3 inches at the centre, the first strake of circumferential plates is then erected and rivetted up, one plate being temporarily fixed with service bolts; this plate is removed after the bottom has been tested with water and lowered on the foundation, so that a winch, oil rivet heater, pole crane and other gear may be installed inside the tank; manholes and pipe inlets are also covered with plates fixed with service bolts. In some large tanks six holes about 6-in. diam. are left in the floor between the periphery and the centre, so that screw jacks can be inserted for lowering purposes. The tank is next filled with water (all openings having been closed) and tested for watertightness, and, if satisfactory, the bottom is tarred underneath, the wood blocks are removed and replaced by screwjacks under the periphery and through the holes in the floor, the tank is then lowered on its foundation.

When erecting the superstructure, various means are employed according to the diameter of the tank. In small tanks a central timber or steel mast is in some cases set up in the centre and stayed with guy ropes, and long jibs are either pivoted to this at the base or a jib is pivoted to a turn-table revolving round the mast, the hauling rope being conveyed to a double purchase winch on the floor of the tank and capable of lifting the pneumatic rivetter and the heaviest plates, which may weigh from 1 to 1½ tons.

Light scaffolding may be provided for the erectors and rivetters, or a plate when lifted is fixed with service bolts by the erectors standing on a small travelling cradle running on the top edge of plates already fixed (as shown in Fig. 7).

In the cases of large tanks, a self-propelled crane mounted on caterpillar treads, and capable of lifting 2 tons, to travel round the tank on the outside is the most suitable method.

In the U.S.A., tanks are also erected by constructing a central steel plate column about 5-ft. diam. on the floor of the tank, the plating being bolted together, on the outside of the column and at about half the height of the tank three or four long jibs are pivoted and stayed to the column, the hauling ropes being conveyed to pulleys at the foot of the jib and at the base of the column, and from thence to a winch.

Reinforced Concrete Tanks

Reinforced concrete tanks have been constructed above ground, two that were built in California on hard clay were so much as 601-ft. in diam. and had a height of 20-ft. 4-in., each containing about 142,000 tons of oil; the roof was of timber boarding supported by numerous wood posts, and with a rise of 1 in 12. In the case of one tank, when the oil had reached a height of 18-ft. 6-in., a 20-ft. length of the top of the wall fell inwards, the oil rushed out and tore 125-ft. length of the wall outwards; there were also some leaks in the 2½-in. thick concrete floor, which was formed of 1 to 7 cement concrete with a reinforcement of wire mesh.

The wall was made of 1 to 5 cement concrete, and this was reinforced with ½-in. diam. horizontal rods 6-in. to 9-in. centres, and ½-in. diam. vertical rods at 3-ft. centres. A cross section of the wall of this tank is illustrated by Fig. 8.

A reinforced concrete tank 100-ft. diam. x 36-ft. 6-in. high, with a base 112-ft. diam. x 2-ft. thick (as shown in the sketch, Fig. 9), will not give a greater load on the ground than a steel tank of the same size resting on a concrete platform 103-ft. diam. x 2-ft. thick, both being loaded with 7,440 tons of oil, the pressure will be 1.05 tons per sq. ft. The concrete for the walls of reinforced concrete tanks should be in the proportions of 1 : 1½ : 3, and in the floors 1 : 2 : 4, with a 4-in. thick top layer of 1 : 1½ : 3, deposited at the same time as the weaker mixture.

In the U.S.A., concrete tanks have been constructed 95-ft. diam. x 17-ft. high for oil fuel above ground, having for reinforcement ½-in. diam. vertical rods at 18-in. centres in the concrete, and horizontal rods 9/16-in. diam., 18-in. centres, outside the wall at the top, ranging to 29/32-in. diam. at 2⅝-in. centres at the bottom, the rods being provided with turnbuckles. The concrete consisted of one part of cement to 1.4 parts of ¾-in. crushed limestone and two parts of 3-in. broken limestone; the weight of the concrete was 160 lbs. cub. ft. One coat of gunnite (liquid cement) was given on the inside and two on the outside.

The erection of concrete tanks involves a large amount of scaffolding and shuttering, and they must be left for some months to harden before they are fit to receive oil; they should preferably be erected on rock or hard ground.

Reservoirs for Oil Fuel

Reservoirs for the storage of oil underground are usually either square or rectangular in plan, and are constructed in a similar manner to those required for water; they may be either partly or entirely buried in the ground. The floor and walls may be of mass concrete or reinforced, and the thickness of the floor will depend upon the character of the sub-soil. The roofs should have a slight rise and are usually of reinforced concrete beams and decking, supported by concrete or brick piers, and covered with several feet of earth. The concrete proportions should be one part cement, two parts of sand and four parts of broken stone (1½-in. gauge), with a 4-in. thick inside layer of finer concrete in the proportion of 1 : 1½ : 3 (½-in. gauge). In some cases hard blue brick tiles, 1-in. thick, or from 3-in. to 4½-in. thickness of blue bricks are used as a facing.

There should be no projections above the ground over or near the reservoirs, such as trees, telegraph poles, hand-railings, etc., and the ventilation pipes should be carried some distance away as a precaution against lightning. Water-tight manhole covers, vent pipes, oil depth gauges, and ladders inside the reservoir will require to be provided. The pivoted swing arm should be provided with a sheet metal cylindrical float, while the oil will require to be pumped into or out of the reservoir. The sketch (Fig. 10) shows a portion of the cross-section of a reservoir partly sunk in the ground. Large reservoirs are sometimes divided by dams, each compartment holding about 50,000 tons of oil; the dams should be carried up to the roof, so that each section is self-contained, with supply and delivery pipes, gauges, ladders, manholes and vent pipes, so that repairs can be carried out in any particular section, independently of the others, after the dangerous gasses have been removed.

(To be continued)

Clyde Navigation Trust

Election of Chairman

At a meeting of the Clyde Navigation Trust on November 20th, **Mr. William Cuthbert** was re-elected Chairman of the Trust and **Mr. James Leggat,** deputy chairman.

In acknowledging his appointment, Mr. Cuthbert alluded to the future of the Clyde Ports and said that the Special Committee set up by the Minister of Transport and the Secretary of State for Scotland to enquire into the constitution and arrangements of the ports in the Clyde area had made its report to the two Ministers. What was in the report they did not know, but whether it became effective in any way was, he thought, a matter of doubt in view of the pronouncement made in Parliament the previous night in regard to Government policy. He did not think the members would expect him to give an expression of opinion on that policy that day, but it was quite evident that there were going to be very far-reaching questions before Parliament, and they would require to be watched most carefully by the harbour authorities as constituted to-day.

Four new members were welcomed to the Trust in the persons of Lord Provost Hector McNeill, a previous member who resigned on his appointment as Regional Port Director, Provost John W. Gibson, Renfrew, Provost Thos. Davidson, Clydebank, and Sir Thos. Dunlop, of the Merchants' House, Glasgow.

*Two New Quays at Tyne Dock, South Shields**

By ALFRED LAIRD HARVEY, M.C., B.A., M.Inst.C.E.

Discussion

(Concluded from page 173)

Mr. Guthrie Brown observed that he was particularly interested in the portion of the Paper dealing with the North-West quay, because about two years ago he had designed a fitting-out wharf abroad for battleships and large aircraft carriers and the site conditions in that country had been very similar to those with which the Author had to deal, although the depth provided alongside was considerably greater, being about 47 feet at low water *(Fig. 8)*.

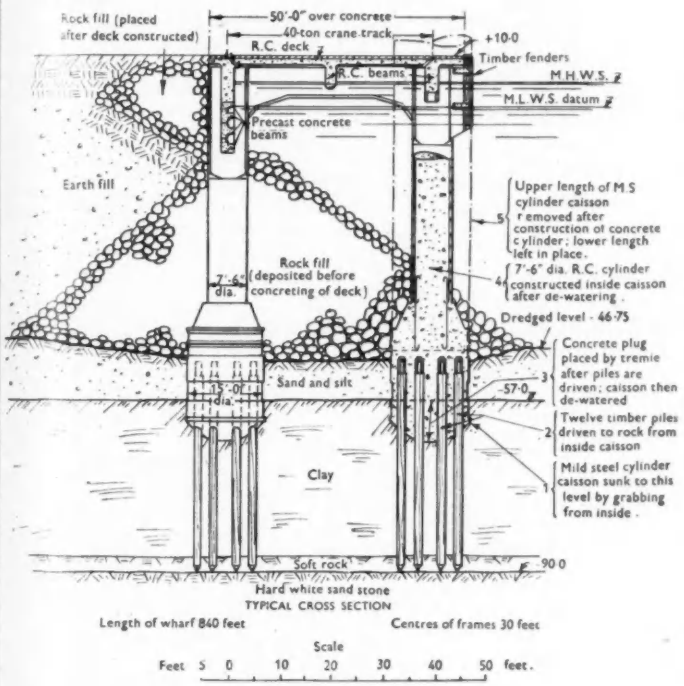

Rock fill (placed after deck constructed)
50'-0" over concrete
40-ton crane track
R.C. deck
+10·0
Timber fenders
R.C. beams
M.H.W.S.
M.L.W.S. datum
Precast concrete beams
Earth fill
Upper length of M.S. cylinder caisson removed after construction of concrete cylinder; lower length left in place.
7'-6" dia. R.C. cylinder constructed inside caisson after de-watering.
Rock fill (deposited before concreting of deck)
7'-6" dia.
Dredged level - 46·75
Concrete plug placed by tremie after piles are driven; caisson then de-watered
15'-0" dia.
Sand and silt
-57·0
Twelve timber piles driven to rock from inside caisson
Clay
Mild steel cylinder caisson sunk to this level by grabbing from inside.
Soft rock
-90·0
Hard white sand stone
TYPICAL CROSS SECTION
Length of wharf 840 feet
Centres of frames 30 feet
Scale
Feet 5 0 10 20 30 40 50 feet.

Fig. 8

The tidal variation was 5 feet and the depth to rock was about 100 feet, both almost identical with the corresponding figures on the Paper. The design was very similar to that adopted by the Author. The steel cylinders, 15 feet diameter, were sunk several feet into the clay which existed below bed level, thereafter timber piles were driven to rock level. The only reason for using timber piles was to expedite construction; Mr. Guthrie Brown would have preferred concrete piles. After the piles were driven, the bottom of the cylinder was sealed with concrete and the water pumped out, the remainder of the concrete work being constructed in the dry; the portion of the steel cylinder above bed-level was then unbolted by diver and removed. The spacing of the piers was 40 feet transversely, to take a 40-ton travelling crane. Longitudinally the piers were at 30-foot centres, the same as that adopted by the Author.

The principal variation in the two designs was the method of dealing with the retained filling. Here it had been possible to obtain large quantities of broken stone and a stone bank deposited after the piers were constructed was adopted. At a level of 10 feet below low water precast concrete beams were fitted between the back row of piers to retain the stone filling up to wharf level. He agreed as to the undesirability of having a large number of beams under the deck and the minimum was used, one under each crane rail and one in the centre of the deck for a rail track. As in the Author's design, transverse stiffness was obtained by a large portal beam spanning between piers.

The Author had used a 1 : 2 : 4 concrete, but Mr. Guthrie Brown had found that such a mix was very unsuitable for work in sea water. The reinforced concrete portions of the wharf he had described were formed with concrete 1 : 1½ : 2, though it was true the site conditions he had to deal with were particularly destructive on steel, timber and concrete.

Sir William Halcrow said that in the early part of this century he had spent two or three years in the town next to Jarrow, namely, Hebburn, building a dry dock. The foundation conditions there were very different. After going through a very thick bed of clay, one got into running sand full of water. Jarrow Slake was looked upon at that time as a terrible place, there being a great depth of mud there.

On the subject of the design of the North-West quay as a whole, he would like to ask whether the Author had ever considered the use of screw piles as a foundation, as the mud was so deep.

In the Paper a description was given of the process of sealing the bottom of the cylinders. It was said that the concrete was deposited through the water and subsequently the cylinder was pumped dry. Many years ago he had been in charge of some work in Italy of a very similar character to that described in the Paper. Cylinders were sunk and piles driven, and the bottom of the cylinder was sealed with concrete placed in bags. In due course he pumped the water out of the cylinders and was horrified to find a substance which looked like butter. He dug it out to a depth of about 2 feet in the cylinders, which were 9 feet in diameter, and below that the concrete was perfectly hard. The water was pumped out (the cylinders were in water about 30 feet deep) and there was no trouble at all at the other end.

Several speakers in the discussion had referred to the fenders, and he had intended to ask the Author whether he had experienced any trouble with them, because there might be projections beyond the normal beam of a ship and ships sometimes took a list when being unloaded. He would also like to know whether the Author had had any trouble with the piles which were supported in the bed of the dock and also at the top. It was true that floating fenders were provided, and he was glad to know that, but he had found that some engineers and those who operated docks had an objection to them.

Mr. Du-Plat-Taylor's statement that the *teredo* in Great Britain had been found only on the south coast was not quite correct, as he had found it in the West Highlands of Scotland. The piles of a pier which he had constructed there had been deeply eaten into by the *teredo*. A very curious feature in that case was that the piles, which were of pitch pine, were quite sound down to a level of 10 feet below low water, but from that level down to the bed of the sea many of the piles were completely eaten away. The *limnoria terebrans*, to which Mr. Du-Plat-Taylor had referred, he had found as far north as the Firth of Forth.

With regard to the tendency of the piles to drift inwards during driving, to which the Author referred, Mr. Ward had suggested a possible explanation of that, and he thought it would be of value if any other explanation could be given.

Mr. J. S. Henzell observed, in writing, that in dock decks of the type described in the Paper there appeared to be a clear field for pre-stressed reinforced concrete (PRC). It had long been established that PRC required less head room for a given load, deflected less under working loads, was less affected by shrinkage, and was altogether more reliable as to expected strength than was ordinary reinforced concrete—qualities all desirable in dock deck construction. The crackless, compressed quality of PRC beam soffits was of the greatest value for decks at or near the surface of sea-water.

It was not stated in the Paper whether the pre-cast deck beams were effective as free spans or continuous. If continuous, details would be of interest in regard to composite shear and bond between in-situ concrete and pre-cast units at the supports, and also at mid span where the pre-cast section had to support the total dead weight of concrete, and construction loads, without assistance

*Paper read at Maritime Engineering Division Meeting of the Institution of Civil Engineers 13th Feb., 1945. Reproduced by permission.

Two New Quays at Tyne Dock, South Shields —continued

from the in-situ slab flanges; with subsequent composite bending effect from live loads. It the pre-cast beams were in effect free spans, consideration had no doubt been given to the lengthening of bottom soffits under tension from live load, the cumulative effect of that over several bays unless corrected, and the means adopted to avoid positive expansion joints in a deck length of 800 feet. Even when advantage was taken of cured pre-cast beams, to minimise shrinkage, and the easing effect of in-situ pockets, and construction joints, it might be expected that temperature-movement could endanger the ends of the structure. Were temperature stresses considered, tensile and bending, in the outer spans or was it anticipated that sufficient longitudinal easing would take place at individual beam pockets (if any) or alternatively in teetering of the main piers down to and below pile groups?

The Author had stated that 1 : 2 : 4 concrete was used for the deck, and certainly a higher grade was to be expected. The Author's explanation would be of interest, as well as for the apparently excessive number of beams, which were surely not necessary for railway tracks. Further interesting points were the wearing surface of slabs, and drainage, of which detailed sketches might be given with beams, slabs and portals. As for continuity of deck beams, no objection could be offered in that case, since the piles were carried down to a hard stratum. The Author's figures for a test pier indicated a ½-inch recovery under total load, with a probable variation of perhaps 1/16th inch under live load. Settlement of that order would not be serious with continuous spans of 30 feet.

The Author's design for the piled portal was an excellent one of its type, and was likely to be much used in the future where only light pile-driving equipment was available. Consideration, however, was necessary as to the economic spacing of portals to support the deck. With light live loads it was possible that a wider spacing than 30 feet would be cheaper and, more important, quicker of construction. Pre-stressed concrete would favour such wider spacing, and a 33-foot spacing would require 10 per cent. fewer beams and piers, and less time in sinking.

As an alternative to the piled portal design, docks of that class might be built more quickly and cheaply by driving longer piles, in that case up to 105 feet, at suitable squared spacings to support a short-span deck. The necessary equipment might be considered over-size for Great Britain, but it was quite common in American practice. Batter piles were used where necessary as bracing against impact of vessels from the outside and causeway soil pressures from the inside, where the close spacing of main piles simplified the design of the bulkhead.

The inward drift of piles during driving, described in the Paper, might be explained as follows. Consolidation, bulking of the silt, built up and increased with the number of piles driven in a cluster. At the very close spacing given (less than twice the diagonal width of a pile for the larger piers) bulking was of such effect that later pile-points, with increasing depth, were deflected outward, away from the pressure-centre of the cluster toward the unconsolidated silt. Upon reaching a certain depth and resistance, therefore, a pile point was gradually forced outward, and the head correspondingly worked inward within the cylinder. For that reason some engineers preferred a squat, truncated point or even a square head for straight driving in clusters. Driving was just as easy and consolidation as effective. Sharp points did not drive as straight in clusters, but might be of value where small plum stones might otherwise block a square hole.

The forward movement of sheet-piling was to some degree explained by the Author's analysis, and such serious movement was undoubtedly best dealt with by the Author's method of dumping selected material against the face of the wall. It would be interesting to know what that emergency operation cost, involving a weight of 3,800 tons. The outward batter of 1 : 12, if carried to the bottom of the sheeting, would indicate a movement approaching 5 feet, from which it would appear that the passive resistance of the outer bank must have been very low, much less than anticipated in the design. Steel sheet-piling, unlike concrete, was very thin and in driving induced little consolidation to increase the passive resistance on the outside and (in some cases) diminish the active pressure on the inside. Perhaps pre-tensioning of the tie-rods, whilst desirable for surface consolidation, reacted unfavourably at the lower levels by increasing the outward pressure against which passive resistance was already barely adequate. Pre-tensioning, even before sliding of the toe, would tend to deflect the sheeting from the driven position, opening a loose space near mid-height between sheeting and backing. That alone would initiate a lateral slide of the backing and aggravate the tendency to squeeze outward under surcharge as described by the Author. The rods, at 10 tons per square inch, were conservatively equal to 50 tons tension, and that should be reconciled with the Author's statement that the anchorages were good for only 20 tons. To what extent did the sheeting move inward and the anchorages outward when the 20 tons were applied to the tie-rods?

For those rods, of 2½ inches diameter, a length of nearly 3 miles was used, weighing 100 tons. Available lengths were not likely to have been more than 42 feet, if as much, so that the longer ties, of 126 feet, would require at least three pieces each, with at least six forged upsets to 3 inches diameter for screwing and coupling. Even if the threads were all right hand, that entailed a slow and expensive operation for the 150 main ties required, the rough bars being shipped from rolling-mill to fabricator and later to the site. It might have been better to ship those rods direct from rolling-mill to the site, for flame cutting and welding. American practice had proved that 2½-inch square reinforcing bars might be trimmed and butt welded stronger than the bar itself at a cost lower than the value of the forty diameters of equivalent bond bar saved: and that in a country where an hour's pay to a welder would buy 50 lb. of steel, in comparison with 12 lb. in Great Britain. Even if butt welds were deprecated they might be augmented by splice covers to details in which the round bars were replaced by suitable flats with fillet welding at the site. A screwed connection would then be necessary at one end only for pre-tensioning, and for that the 3-inch upset might be replaced by two round stubs of smaller diameter, welded to the flat. At the anchor end, the sheeting might be slotted by burning, to pass the flat tie fitted with a welded stop. As for severe pre-tensioning against the sheet-piling, however, the Author had not stated his reasons for and against in the Paper.

In constructing the Sutherland quay, the Author's decision to drive new bents midway between those existing at 16-foot centres led to a very practical design easy to execute, but Mr. Henzell presumed that the unexpectedly encountered hard clay about 28 feet below low water was fully investigated before deciding to reply upon it. To what depth did it extend and by what was it underlain?

In preparing timber to be placed below high water level, were cutting, notching, and drilling performed before creosoting or after?

Mr. R. F. Hindmarsh observed that the desire to proceed with the development of the river frontage to the west of the entrance to Tyne Dock and in the Jarrow Slake area was one of the main reasons for the acquisition of the dock by the Tyne Improvement Commissioners in 1937 and it was only on account of the war that the original project for a reinforced-concrete quay along the whole length of the river frontage was not proceeded with. The Ministry of War Transport required a quay there and defrayed a substantial part of the cost of the Sutherland quay, which could be extended for about 900 feet eastwards towards the dock entrance whenever required.

The North-West quay was designed primarily for the timber and iron ore trades, and the cranes had sufficient outreach to discharge over the side of the vessel into lighters, and to span all the railway lines behind the quay. The 10/5-ton crane was provided to deal with war-time traffic, which had largely monopolised both quays since their completion.

The method adopted for sinking the trial cylinder led up to the design described in the Paper, which was considered better than the method sometimes adopted of placing concrete cylinders over groups of piles and filling them with concrete.

The fendering on the North-West quay had been very successful and no damage had so far been done to it, except when accidentally struck bow on, etc. There was no appreciable run of tide in the dock, and something more substantial would probably be required in a tideway. It was largely constructed with timber

Two New Quays at Tyne Dock, South Shields—*continued*

derived from the contractor's staging and cost only about £3,325.

The Author had mentioned the provision of a row of whinstone sets on both sides of each rail on the deck. That method of laying the railways had the advantage that rails could be taken up and renewed without interfering with the concrete. The filling behind the steel-piled bulkhead was obtained on favourable terms from the South Shields Corporation, who were engaged at the time in a clearance scheme, and had proved very suitable.

The dredging was done immediately after the sheet-piling had been driven and before the construction of the cylinder quay was begun and the slight movement of the sheet-piling referred to by the Author took place before the construction of the quay was commenced. No movement had occurred since its completion.

Although the North-West quay was not completed until a year and three-quarters after the outbreak of war, its cost was not increased to any great extent on that account, most of the materials having been ordered before prices increased.

Originally it had been intended to complete the Sutherland quay, which was entirely undertaken in war-time, in 9 months; but owing to the demands of the shipyards it was impossible to obtain a sufficiency of suitable labour and it actually took about 19 months, including the transit shed and considerably extended exchange sidings, which were additional to the original scheme.

The Author, in reply, observed that he was very pleased that so many points had been raised in the discussion.

He wished to pay a tribute to the work of the Contractors, Messrs. Brims & Company, Limited.

With regard to the cost of the two quays, the North-West quay was begun under peace-time conditions and was finished, with very little additional cost, during the war. The Sutherland quay was begun during the war and it was not possible to acquire the materials at pre-war prices.

Several speakers had referred to the costs per foot run, basing their remarks on the figures summarized in Appendix II, which took into account the works behind the quays.

The relative costs of the two quays, including the quay structures, the railways, crane track, bollards and hydrants thereon, the sheet piling, anchorages and filling, but excluding dredging, cranes, capstans and electrical equipment and other works behind the quays, were as follows:—

North-West quay—£195 per linear foot of berth (800 feet) or £3.18 per square foot of deck.
Sutherland quay—£307 per linear foot of berth (450 feet) or £2.82 per square foot of deck.*

The deck area of both quays was practically identical.

On the same basis, the estimated pre-war cost of the proposed reinforced concrete quay, referred to by Mr. Buckton, with a length of berth of 1,417 feet and a quay width of 62 feet 4 inches, was £281 per linear foot of berth or £4 per square foot of deck.

Mr. Buckton had, he thought, been too pessimistic regarding the prospective life of the Sutherland quay. Timber had had a good record of useful service in that part of the river. For example, the timber piles of the Oil Fuel jetty at the west side of the Jarrow Slake (Fig. 1, Plate 1), built in 1922, were still in good condition except for the two front rows which had had to be sleeved in 1937.

Mr. Du-Plat-Taylor had referred to marine timber borers, their action on timber structures in that part of the river had been confined principally to the front row of piling in each case, from about 2 feet to 14 feet above the mud line or about 27 feet to 15 feet below Low Water of Ordinary Spring Tides. That was why the piling driven in 1914 by the North Eastern Railway, which was all above low water mark, had not been attacked (Fig. 7). The species had been definitely identified as *limnoria terebrans* at the Dove Marine Laboratory, Cullercoats.

In answer to Mr. Henzell, there was no cutting or notching of timber below high water mark at the Sutherland quay, but the drilling of bracing had been carried out after creosoting. The hard clay in front of the berth, unexpectedly encountered during the dredging, had not been specially investigated.

Turning to the North-West quay, a number of speakers had referred to the fendering. As stated by Mr. Hindmarsh in his written contribution, it had proved very successful and it had not so far been necessary to replace any of the rubber buffers. The Author had more confidence in them than in coiled springs which, unless properly maintained, were liable to get choked with rust and dirt.

In reply to Mr. Palmer, the rubber buffers were designed to transmit 14 tons to the structure with about 3 inches compression, so that their capacity for absorbing kinetic energy was about 21 inch-tons. An infinite number of examples of collision could be taken depending upon the weight, speed, and angle of approach of a ship, but considering the case of a vessel coming alongside at high tide and striking the floating fender immediately opposite one of the buffers, calculation showed that the timber pile absorbed about 13 inch-tons by the time the reaction on the rubber buffer had reached 14 tons. Therefore the total absorption of a single fender under those conditions was about 34 inch-tons. Thirty-four inch-tons was equivalent to the work done in bringing to rest the vessel illustrated in the Paper, which had a displacement of 13,533 tons, striking a single fender amidships at a speed of 7 feet per minute. Higher speeds than that would, of course, be permissible in practice, as the blow would almost always be a glancing one, delivered by the forward part of the vessel, and the adjoining fenders would absorb a proportion of the energy as well.

Mr. Palmer had also asked why the end of the North-West quay had not been brought into alignment with the face of the Iron Ore quay. It was unnecessary to do that as the life of the Iron Ore quay was almost at an end and in the event of the North-West quay being extended southward more water space in the dock would be desirable.

Mr. Shepherd-Barron had raised the question of the use of the quay cranes for the discharge of iron ore.

The grabs for the 3-ton cranes had a capacity of 21/17 cubic feet for a weight empty of 35 cwts., while for the 5/2½-ton cranes, the capacity was 38/30 cubic feet and the weight empty 55½ cwts. They had been designed for ore having an average weight of 17 cubic feet per ton. When used in discharging washed iron ore concentrates, which were easily grabbed but heavy, the grabs picked up a heaped load each time and overloaded the crane. That difficulty had been partly overcome by removing the teeth and fitting removable bosom plates, thereby reducing the weight lifted by 10 cwts.

As regards output, he had not been able to obtain separate figures for the grabs used on the 3 and 5 ton cranes respectively, but, in a recent case, where both sizes had been used for the discharge of 8,064 tons of iron ore concentrates from two ships, the average output had been 43.4 tons per crane per hour.

He agreed that a large heavy grab for ore gave the best output, but that involved bigger cranes. In the case of the North-West quay and Sutherland quay, many types of cargoes had to be dealt with and the sizes and capacities of the cranes were felt to be the best compromise possible in the circumstances.

Mr. Shepherd-Barron had also commented on the absence of expansion joints in the North-West quay deck. The difference in the average weekly temperature between July and January in north-east England was about 22° F., and the thickness of the deck slab and the concrete paving provided good protection against sudden changes. No cracks whatever had appeared, but the construction joints in the deck slab showed the usual thin line of efflorescence on the underside. The total length of the deck was 948 feet.

Mr. Buckton, Mr. Gwyther and Mr. Guthrie Brown had thought the number of beams excessive. He did not think a thick deck would have been at all economical in this case; it would also have added to the dead load on the piles, which was considerable enough as it was.

The cover on the main reinforcing bars in the beams was 1½ inches and the underside of the deck and the beams had been given two coats of a bituminous preparation.

Mr. Gwyther, with other speakers, had also referred to the tie-rods and he agreed with them that forged ends and turnbuckles might well be superseded by something less costly, if it could be devised. The anchorage, however, had successfully fulfilled its function and there was no need for it to have been any larger. The tie-rods were tightened up as the filling proceeded and were all buried before the dredging was begun. The pull per rod was

*Excluding the value of the sheet-piling and piling already driven.

Two New Quays at Tyne Dock, South Shields—continued

not likely to be much in excess of 20 tons on account of the bearing capacity of the soil.

Reference had been made by Mr. Ward, Sir William Halcrow and Mr. Henzell, to the drifting of the piles at the North-West quay. He thought the matter was of some practical interest in view of the unusual depth to which the piles had been dollied down, in such poor material.

* Excluding the value of the sheet-piling and piling already driven.

The conditions obtaining in the trial cylinder and quay cylinders were somewhat dissimilar. The trial cylinder was sunk through 43 feet of silt and the piles were driven in the dry, whereas the maximum pentration of the quay cylinder was only about 25 feet, and pile-driving was carried out through water. There was, therefore, in the case of the trial cylinder, a considerable external pressure tending to cause the silt to well up inside the cylinder around the cutting-edge. On the other hand, in the case of the quay cylinders, there was very little external pressure on the silt at the bottom of the cylinders, and what flow took place would be entirely attributable to displacement of the silt during pile-driving. In the case of the trial cylinder, therefore, it appeared probable that the piles were forced inwards at the head during the last 5 feet of driving by the silt entering the cylinder at its periphery, the piles then being clear of the leaders and only being held by the dolly-pin, whereas in the case of the quay cylinders it was the core of displaced material, rising within the ring of piles during driving, which caused the surrounding silt to flow in from below and draw the pile-points together.

He would like to thank Mr. Packshaw for his remarks regarding the utility and limitations of ground testing plant and could only wish he had found time to elaborate the examples he had given of the pile driven into soft clay and the circumstances in which the carrying capacity of a single pile had been smaller than that of individual piles in a group.

With regard to the forward movement of the sheet-piling at the North-West quay, he quite agreed with Mr. Packshaw that the outward thrust of the filling at the centre of the quay was probably very small. The ratio of embedded length of sheet-piling to the height of supported ground at the ends of the quay was 1.4 and, taking that ratio as a rough and ready guide for the piling in the zone of movement, it would appear that the piles near the centre of the quay should have been some 10 feet longer, i.e., about 73 feet instead of 63 feet.

Sir William Halcrow, in summing up the discussion, had referred to the buttery substance (laitance) he had found inside cylinders when pumped out after sealing.

Very little of that substance had been found in the case of the North-West quay cylinders, the maximum thickness being about 2 inches.

The use of screw-piling, as an alternative to cylinders and piles, had been thought of, but had not been pursued in view of the presence of a satisfactory foundation which could be reached, not only by the method adopted, but also, if obstructions had been encountered, by cylinders sunk under compressed air.

Mr. Henzell had asked about the design of the deck. The deck beams were continuous and the pre-cast portions were designed to carry the bending moment and shear due to the total dead load including the weight of the deck slab. The stresses thereby induced were considered to be " sealed " or " locked " in the pre-cast portion. The live load stresses were then added, taking into account the effect of the slab flanges. It was felt that the cranked bars and shear reinforcement projecting from the pre-cast work would considerably assist the bond between the pre-cast and in-situ concrete; the ends of the pre-cast beams were also cast with a slight bevel and thoroughly roughened before the in-situ concrete was placed. The whole of the shear, however, was considered as being taken by the reinforcement.

The cost of the selected material deposited in front of the toe of the sheet-piling at the North-West quay was 6s. per ton.

South Wales Ports Changes

Retirement of Divisional Docks Engineer

Mr. M. C. Harrison, M.Inst.C.E., the Divisional Docks Engineer, Great Western Railway, Barry, who is responsible for the Company's Docks at Newport, Cardiff, Penarth and Barry, in South Wales, is retiring at the end of the year. He was a pupil of the late Mr. James Bell, Engineer to the former Barry Dock and Railway Company, and, on completion of his articles, was taken on the staff of that Company and was engaged upon the construction of the East Dock (now No. 2) at Barry and upon the construction of various branch railways of the Barry Railway Company under Sir John Wolfe Barry. In 1903 he was appointed Assistant Engineer and in that capacity was responsible, under the Chief Engineer, for carrying out the renewal in steel and ferro-concrete of the high level coal hoist gantries, the layout and foundation works for five additional 20-ton hoists in No. 1 Dock, Barry, the construction of additional hydraulic power houses, and the overhauling and renewal of the dock and lock entrance gates.

In 1919, Mr. Harrison was appointed Chief Engineer to the Barry and Vale of Glamorgan Railway Companys, which position he held at the time of the amalgamation of the railways in 1922, when he was appointed Resident Docks Engineer, Barry and Penarth Docks. In 1925, he was appointed Divisional (Railway) Engineer at Newport and returned to Barry in 1931 upon appointment to the position he will now vacate.

As Divisional Docks Engineer, Mr. Harrison has been responsible for the maintenance and renewal works at the docks, and, in the years prior to the war, for the carrying out of an extensive programme of works in connection with the modernisation of the docks and port facilities. As a result of the war and the consequent diversion of traffic from the east coast ports to the west, considerable additional sidings and other facilities were provided to deal with the increased traffic, and the ports were maintained to the maximum capacity under very difficult circumstances, for the whole of which work he was responsible. Further, the Dock at Penarth, which had been closed to traffic for some years, was re-opened for Government traffic, necessitating a complete re-modelling of its facilities.

Mr. Harrison, who is a Member of the Institution of Civil Engineers, has twice been Chairman of the South Wales and Monmouthshire Association of that Institution. He is a Harbour Commissioner at Newport and is on the Advisory Board for Technical Education in South Wales and Monmouthshire, and the Technical Advisory Committee of the Cardiff Technical College.

Lt.-Col. R. H. Edwards, Assoc.M.Inst.C.E., who has been appointed Divisional Docks Engineer, Barry, G.W.R., from 1st January next on the retirement of Mr. M. C. Harrison, served his pupilage with the Chief Engineer of the former Taff Vale Railway and was afterwards appointed to the engineering staff of that Company in 1920. Subsequently, under the G.W.R., he held appointments at Penarth Dock, Barry Docks, Newport, and at Paddington. In 1932, he was appointed Assistant at Newport Docks and the following year to a similar position at Cardiff Docks, and in 1937 was promoted Assistant Divisional Docks Engineer, Barry. In August, 1939, he was embodied with the Army Supplementary Reserve and remained on active service until February this year, when, at the request of the G.W.R., he was specially released and on return to this country was re-appointed Assistant Divisional Docks Engineer, which position he will vacate to take up his new appointment as Divisional Docks Engineer.

Restoration of Port of Hong Kong

The rehabilitation of the Port of Hong Kong is reported to be so far advanced that the port is ready to receive commercial traffic. The harbour fairway has been cleared and the channels re-buoyed and lighted. Twenty visible wrecks and a great number of submerged craft are being moved from the harbour area.

Cape Town Graving Dock

There has been some discrepancy in published statements in the Press regarding the size of the Sturrock Graving Dock, recently opened at Cape Town. Through the courtesy of the Civil Engineer-in-Chief of the Admiralty, we are able to give the following authentic official dimensions:

Length from Head to Entrance Copings, 1,248-ft.
Length from Head to Caisson in Main Groove, 1,181-ft.
Length from Head to Caisson in Outer Groove, 1,212-ft. 5-in.
Width at Entrance Coping Level, 148-ft.
Width at Barrel Coping Level, 156-ft.
Depth of Cill at Entrance below L.W.O.S.T., 40-ft.
Depth at Cill at Entrance below H.W.O.S.T., 45-ft. 9-in.

The following additional particulars were furnished to the South African press by Lieut.-Col. D. E. Paterson, O.B.E., M.C., M.Inst.C.E., the Harbour Engineer at Cape Town. He said:

Cape Town's new graving dock is bigger than the one recently opened at Sydney, Australia, and embodies features which give it many advantages.

The Sydney dock cost £9,000,000, whereas the cost of the Cape Town dock will be £3,500,000. Part of the cost of the Table Bay dock is being borne by the British Government, which supplied machinery and equipment not obtainable in South Africa.

The dock can be so divided that more than one ship can be accommodated at a time. Two vessels, one up to 709 feet long and the other up to 434 feet, can be safely docked at the same time by adjusting the floating caisson.

One floating caisson is still under construction and is not expected to be completed until early next year. The caisson at the entrance to the dock weighs more than 2,000 tons.

The depth of water on the sill at high water is 45 feet 9 inches, which is considerably more than the deepest draught of the Queen Elizabeth, and the entrance is 148 feet wide.

The dock, which holds 55,000,000 gallons of water, can be filled in just over an hour, and the huge pumps can empty it in 4½ hours.

The actual construction time for the dock is only 16 months. It is believed that some records were set up in the placing of the concrete; during one 9½-hour day, 2,132 cubic yards were laid.

In the excavating work, 716,000 cubic yards of soil were removed by bucket dredger, and road transport lifted 268,500 cubic yards of dry soil before the coffer dam was closed. The dock has used 340,000 cubic yards of concrete.

Boston (U.S.A.) Port Authority.

The American Press announces the formation of a new "unpaid policy-making board" for the Port of Boston, including Messrs. John F. Fitzgerald (former mayor and member of the Authority), Louis Edgehill, Henry J. Nichols, John J. Del Monte, and James R. Nolen.

Dundee Harbour Accounts

The Dundee Chamber of Commerce recently heard an address from Mr. J. Murray Prain, their representative on the Dundee Harbour Board. In the course of his address, Mr. Prain said that the accounts for the financial year, which ended on May 31st last, showed a total ordinary revenue for the harbour undertaking of £162,097, compared with £135,977 for the year ended May 31st, 1939, while on the other hand the total ordinary expenditure for the past financial year was £110,855, compared with £108,170 for the year ended May 31st, 1939.

As to the immediate future, it would seem that a considerable reduction in revenue would take place, due to Government Departments ceasing to utilise facilities at the harbour, while wages and materials would continue at a high level. Revenue for the past quarter showed a decrease of £15,000 compared with the corresponding quarter last year. The dockers' strike complicated matters. The Trustees might require to increase rates again, in order to balance accounts.

Clyde Navigation Trust

Important Development Plans

Projects for new works and factories and a quay wall involving considerable outlay, were approved by the Clyde Navigation Trust at their meeting on November 6th. The lay-out of the factories provides for the use of 126 acres. It is proposed to serve the estate by a 4,000-ft. quay wall estimated to cost £2,500,000, towards which the Ministry of War Transport and the Board of Trade have been asked to make a substantial grant.

The scheme, which had been under the consideration of the General Purposes Committee for some months, received the unanimous approval of the members, including Labour representatives of the Corporation, some of whom have taken a leading part in the negotiations. It is certain all the factory space will be utilised for new industries.

The proposed quay wall will stretch 4,000-ft. from Shieldhall to Renfrew, and provide the new factories with wharf facilities for loading and unloading cargoes. On its erection the Scottish Co-operative Wholesale Society will lease an 8-acres site for a flour mill, and Messrs. J. Bibby & Sons, Liverpool, a 10-acres site for a cattle food factory.

These two projects, with plant and equipment, may cost £1,000,000, and will bring grain cargoes to the harbour.

The Central Electricity Board and Glasgow Corporation have taken a site at Shieldhall on which to erect the power station. The Central Electricity Board will construct additional buildings.

The Clan Line Steamers, Ltd., are to build repair shops and stores at the King George V Dock, Shieldhall, while the City Line, Ltd., will take up new berthage at Princes Dock.

Some of the land will be reserved for harbour development. The tendency is for the bigger shipping services to migrate westward to sites north and south of the river, and the facilities for the companies will be provided by the Trust to ensure that the importance of the harbour as a world trading centre will be maintained.

In submitting the proposals for the approval of the Trustees, the chairman made the following observations:

"The arrangements referred to in the Minute for the accommodation of factories and industries are of the utmost importance to Glasgow and District. Areas for no fewer than ten companies were to be occupied and it is notable that in all cases there is room for considerable expansion. All the Shieldhall lands are taken up, but at Renfrew there is still room for additional factories. The Trustees' policy has been to accommodate at Shieldhall and Renfrew factories and industries requiring nearby shipping services for all parts of the world, so that manufacturers may be in the best position to compete in all markets.

"King George V Dock, now one of the best in the country, is close by and if Government approval and grant were obtained for the Renfrew Riverside Quay, the attractiveness of the Renfrew lands for factories would be greatly increased to the national advantage. Indeed, it will be seen from the Minute that two large projects—a mill for the S.C.W.S. on an 8-acre site and a cattle food factory for Messrs. J. Bibby & Sons, Ltd., on a 10-acre site—only await the quay wall for conclusion.

"Glasgow industrialists may depend on the fullest support and backing from all the Shipping Companies who are alive to the stern problems of the future and will play their part in giving a world service. Before the war the Blue Funnel Line had their berthage at King George V Dock. They will continue there with improved arrangements. The Clan Line will go to the West side of the Dock and the accommodation there will be a great improvement on their former accommodation at Queen's Dock. The City Line will take up improved berthage at Prince's Dock. These are a few examples, but arrangements and improvements by other Shipping Lines and Companies are also in hand."

Proposed Free Ports in Canada

A Federal Government Committee, under the Chairmanship of Mr. J. E. St. Laurent, Vice-Chairman of the Canadian National Harbours Board, is engaged in investigating the possibility of establishing free ports in Canada.

Tyne Improvement Commission

Appointment of New Chairman and Deputy Chairman

At the Annual Meeting of the Tyne Improvement Commission on November 20th, Sir Arthur M. Sutherland, Bt., and Col. Sir Frank R. Simpson, Bt., resigned their respective positions as Chairman and Deputy Chairman. Mr. W. A. Souter, of Messrs. W. A. Souter & Co., Ltd., Newcastle, was elected Chairman, and Mr. Alfred Rayner (local Director of Messrs. Wm. Cory & Sons, Ltd.) was elected Deputy Chairman.

Retiring Chairman on Records of the Past.

In his valedictory address from the Chair, **Sir Arthur Sutherland** said:

As you all know, to-day I vacate the Chair of the Tyne Improvement Commission, which I have had the honour to hold for ten eventful years. While naturally the giving up of this interesting and honourable position is tinged with regret, yet it gives me the greatest possible pleasure to feel that my successor is one in whose hands we may be assured that the Commission will go on from strength to strength.

One hears—and it is right that one should hear—of the activities of our City Corporation, but I do not think that the public realise what a great work the Tyne Improvement Commission does for the district. The Commission was established in 1850—95 years ago—and in that time our river has been transformed from a shallow waterway of sand shoals to one of the premier ports of the Kingdom.

One of our major duties is to maintain an adequate fairway to accommodate large vessels and in an average year about two million tons of material are dredged from the river. The dredged depth varies from 45 feet to 40 feet at H.W.O.S.T. for a distance of about 14 miles inland. The annual cost of maintenance dredging is about £40,000.

I have seen, during my 34 years of membership of this Board, a great many changes, most of which have been for the good of Tyneside. As we measure the distance on a road by milestones, so we unconsciously measure time by events, and it has been my privilege, during my years as Chairman, to be associated with some major enterprises.

In 1936 the Duke and Duchess of York officially opened Jarrow Staith. This Staith is equipped with band conveyors which can ship coal at the rate of 500 tons per hour. The cost was £186,000.

In 1937 we officially opened the Tyne Commission Quay Extension at Albert Edward Dock. This quay, and the Bergen Quay, opened in 1928, were specially built for the Scandinavian trade and have direct train service with London. The quays and facilities cost £326,000. In the same year we purchased Tyne Dock from the London & North Eastern Railway Company at a cost of £600,000 and since then we have expended about £600,000 on improving the Dock and bringing its facilities up to date.

In 1938 we completed building the Quay at Willington for the Tyne Plywood Works, costing £28,000, and finished the widening of the river at Felling Point at a cost of £15,000.

In 1939, just before the outbreak of war, Hebburn Quay, adjacent to Jarrow Staiths, was built at an expenditure of £30,000.

In 1941, under war conditions, we finished the great 800 feet quay in the North West corner of Tyne Dock. This scheme cost £258,000.

In 1942 the deep water quay on the river side of Tyne Dock, at present 450 feet in length, with its transit shed, was opened for trade. I was greatly honoured by this quay being called the Sutherland Quay. The expenditure on the quay and facilities was about £300,000.

These are the major works, but there are many others which have been carried out during my term of office, which included six years of the greatest war in history. It is a tribute to our financial stability that we have been able to find the capital for these works, and to find that capital at rates of interest which can be compared with any other security available in this country to-day.

New Chairman on Prospects of the Future.

In returning thanks after his election, **Mr. Souter** said:

Sir Arthur has described the considerable additions which have been made to our port facilities in the last ten years. Whilst we must watch carefully the course of events, my view is that our present facilities are fully adequate to cope with the probable volume of trade for some time to come, and that it will be unnecessary and undesirable to undertake any further major capital expenditure for some years. There are, however, two improvements which the Commission would wish to make if the course of trade is seen to warrant them, and these are the extension of the Sutherland Quay and the further deepening of the lower reaches of the river. Sir Arthur has mentioned that we have now a deep water channel at high tide of 45 to 40 feet. Before the war plans were made to increase this to 50 to 45 feet, and I hope it will be possible to carry out this improvement during my period of office.

It must be remembered that it is necessary to meet the Interest and Redemption on Capital Expenditure, and these sums are already large in respect of the excellent facilities we already possess. Our total expenditure last year was £1,140,649, and of this amount redemption of debt amounted to £130,000 and interest to £125,000, a little over a total of a quarter of a million. This year the amount of redemption will be increased by about £5,000, and the interest reduced by approximately a similar amount. Each succeeding year the amount of redemption will be more and the amount of interest will be less. By their Acts of 1872/1898 the Commissioners are under an obligation to repay the major portion of their debt by 1958, that is to say, only 13 years ahead. In that year the amount of redemption will be about £197,000 and the interest, unless we assume additional capital obligations, will be correspondingly reduced. Thereafter the interest and loan redemption charge would be so greatly reduced that a reduction in dues of about one-third based upon the present volume of trade, might be possible. For the future, therefore, it must be a matter of careful consideration for the Commissioners whether it will be better policy to attract trade by providing additional port facilities, which means additional capital expenditure, or by a reduction in dues.

The year 1958, however, is a long way ahead and an early reduction in dues which are standing at 100 per cent. above pre-war is very desirable; it is, however, largely dependent on an increase in the volume of trade, and particularly the export of coal. The shipment of coal this year, and for the last two years, has been at about the rate of 5 million tons a year, which compares with a ten year average pre-war of over 14 million tons. Of the 5 million tons shipped last year, only 9 per cent. went foreign. What we want, and what the country wants, is exports. Abundant exports of coal would not only mean lower dues; they would mean cheaper return cargoes of imports. The production of coal in this country is beyond our province, but we can only hope that before long there will be a considerable increase in the output. If there is such an increase, we have all the facilities on this river to ship it, and there is no doubt about the keen demand for coal from abroad.

The new light industries which are being established in this district are very welcome, and as far as the shipment of their products is concerned, and the import of the raw materials they use, the Commission will give all possible assistance.

A photograph and biographical sketch of Sir Arthur Munro Sutherland, Bt., K.B.E., D.C.L., D.L., J.P., appeared in the issue of this Journal for March, 1942 (Vol. XXII., p. 79).

Salvage of Floating Dock.

An official report made in October that a 50,000-ton floating dock was raised from the bottom of Trincomalee Harbour, Ceylon, was the first public disclosure of the capsizal of the dock which occurred on August 8th, 1944, while the battleship *Valiant* was being placed in it.

Legal Notes

Responsibility for Defective Chain Sling

An action in the Liverpool Court of Passage was brought on September 26th by Mr. William Heeson, a carter, against the Mersey Docks and Harbour Board for damages on account of injuries received when a sling chain, carrying a box of bacon, broke at a defective link.

The following report is extracted from *Lloyd's List*.

Mr. A. D. Pappworth, for the plaintiff, said that on January 22nd last Heeson was employed by a firm of carters, and at East Toxteth Dock he was loading on to his cart boxes of bacon weighing over 2 cwt., when, owing to the link of a chain opening, a box fell on him and threw him to the ground.

Mr. Glynn Blackledge, for the defendants, said it was agreed that plaintiff was injured by a box falling through the breaking of a link in the chain and that the chain belonged to the Docks Board at the time. Defendants pleaded latent defect.

Police Sergeant B. H. Tankard, of the Liverpool City Police, stated in evidence that immediately after the accident he saw the plaintiff, Heeson, sitting on the ground. He examined a jigger chain sling and found that one of the links had parted at the joint of the weld.

Mr. L. Keyworth, superintendent of the Docks Board's chain-testing works at Birkenhead, said that the chain was taken to his department for repair last year and 10-ft. of new chain was built into it. It was tested after repair on December 4th last with a proof load of 15 cwt., twice its safe working load. After the test it was examined link by link by the chain examiners and was passed as safe. The broken link was in the new part of the chain and the weld was defective, but that could not be seen by ordinary observation before the accident.

Mr. J. Savoury, jigger man in the employ of the Docks Board, stated that he examined the chain before he issued it and did not notice any defect.

Mr. P. J. Maddock, civil and consulting engineer, gave evidence that the link showed signs of adhesion of metal along the outside of the link only, and there was furnace slag inside the weld. The defect would not be visible before the accident, as it would show an apparently perfect join. A side pull on the chain or a sudden jerk might have caused the weld to open.

Sir W. F. K. Taylor, giving judgment, held that the fault was not visible on inspection and, that being so, the Docks Board were not guilty of negligence in testing the chain, and that was the only charge made against them. His Lordship gave judgment for the defendants, with costs.

Interpretation of Dock Regulation

A point of considerable importance to stevedores was raised before the Liverpool Stipendiary Magistrate on October 18th when H.M. Inspector of Factories prosecuted Cunard-White Star, Ltd., for an alleged breach of Docks Regulation No. 42, in that a beam of the main deck hatch was not " adequately " secured to prevent displacement, which actually took place, resulting in a fatal accident to a docker (William Major), who was working on the ship *Prometheus* at the South Huskisson Dock at the time, engaged in loading machinery into the hold.

Mr. H. Hudson, H.M. Inspector of Factories, who prosecuted, said the accident occurred at 8 a.m., while eight men were employed in the 'tween deck receiving heavy cases of machinery on board the vessel. On the main deck only two or three sections of the hatch covers had been removed, leaving one section in position held by the usual 'thwartship beam. It was the case of the prosecution that no steps by any responsible official of the firm had been taken to see that that hatch beam was removed or adequately secured before the work was commenced. One of the men prior to going into the 'tween deck took it on himself to examine this beam for his own protection, and to put a bolt into the port end of the beam. Work then proceeded normally and after 10 of these heavy cases had been loaded into the 'tween deck, another case weighing about three-quarters-of-a-ton was sent down and about to be landed immediately under the beam. After some manœuvring the case was landed and the man Major was seen to disconnect the hook of the wire rope fall and signal for the empty fall to go up. It went up about a foot and then a hatch cover was seen to come tumbling down and struck the unfortunate man on the back of the head before he could get out of the way. He was taken to hospital, where he died the same day, from a fractured skull, as a result of the accident. Mr. Hudson added that almost immediately after this incident the beam was dislodged again and other hatch covers fell. It was the submission of the prosecution that there had been a plain failure of the defendant company adequately to secure the 'thwartship beam.

Captain Alfred West, master mariner, employed by Cunard White Star, Ltd.; was called on behalf of the defendant company, who pleaded not guilty. He said he was well aware of the regulations, and he saw to it that all his foremen were also well aware of them. He said his firm had a name for being particularly careful that these bye-laws were carried out to the very letter.

Mr. Leo Gradwell, on behalf of the Cunard White Star, said they were proud of the reputation they held, and they therefore regarded this case very seriously. The firm always did their utmost by employing the best of men and using the best of material. He suggested that the point at issue was as to whether the beams were adequately secured, and it therefore became a question as to what the word " adequately " really meant. The law said the firm was not bound absolutely to ensure the beam should never be moved, but they should do everything in their power to prevent it being moved. He contended that when the bolt had been put through the beam the firm had done everything they possibly could. They could not guard against the completely unexpected. Something must have happened in this case of an unusual nature, to meet which the adequate securing mentioned in the regulations was not enough. Under those circumstances he submitted that the defendant company was entitled to be acquitted. They had done all they could, and the direct evidence showed that both ends of the beam had been secured by the means that were provided.

The Stipendiary (Mr. Stuart Deacon): I think the word " adequately " does mean adequately. If I tried to translate it into my own language I should say the word might be " effectively."

Mr. Hudson submitted that " adequately " called for something that must be 100 per cent. adequate.

Mr. Gradwell: If that means absolute security, what is the necessity for the word " adequately? " I submit " adequately secured " means sensibly secured.

The Stipendiary said he must find the case proved, adding: " I need hardly say, being a magistrate in the City of Liverpool, that what has been referred to by Counsel as to the credit and reputation of the defendant company requires no words of confirmation from a Liverpool Court."

A fine was imposed of £30 with 7s. 6d. costs.

British Dock Workers' Claims

At the time of going to press last month, the dispute between British dock workers and their employers was still unsettled, although practically immediately afterwards (on November 5th), tardily following the advice of their Unions, the men went back to work with the threat that if their demands were not conceded within 30 days they would foment a national strike.

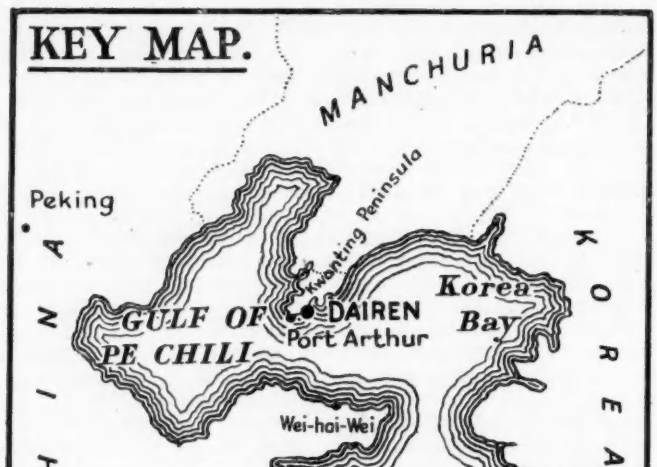
The month has almost expired, and, so far, the matter is no nearer settlement. Nor does there seem much likelihood, or possibility of agreement. The Unions have issued a statement to the effect that the employers' proposals are inadequate and could not be recommended for acceptance to the national delegate conference, which is due to be held early in December.

A report on the discussions is being made to the Ministry of Labour and the question as to whether there will be any further negotiations depends on circumstances which at the moment are somewhat obscure.

The Port of Dairen

Future Prospects of a Far-Eastern Harbour

The inclusion in the Russo-Chinese Treaty of provision for a joint administration of the port of Dairen (Dalny) on the Kwantung Peninsula is of great interest, as it has infinite possibilities of trade development. The name is a Japanese adaptation of its old Chinese name of Tailen or Talien, brought about by the Japanese difficulty in pronouncing the letter "L," and for centuries it was little more than a name with a few wretched Chinese fishermen's huts on the mud. The old Chinese mandarin policy of concentrating trade where it could most easily be taxed caused them to waste the opportunities of the finest ice-free sheltered bay on the Yellow Sea.



The Russians saw its advantages and when they leased the Liao-Yang Peninsula in 1898 they immediately started to lay it out as the commercial counterpart of the naval base of Port Arthur, christening it Dalny, which means "The Far Away." By a colossal outlay of money and labour, and very large scale plans for the port and town, they made rapid progress, so that the first part was completed and the port opened in 1901, and immediately secured an extensive hinterland by being made one terminus of the South Manchurian Railway. The breakwater caused a certain amount of ice difficulty in the inner harbour in very severe weather, but otherwise the Russians' plans were excellent, although many considered that they would have been much wiser to have chosen the Dairen site as the naval base instead of Port Arthur, which was very much more impeded by ice and infinitely more cramped for space.

They certainly made a mistake, considering their position in the Far East, in holding up its fortifications while all their efforts in that direction were devoted to Port Arthur, for on the 28th May, 1904, the Japanese captured it with practically no opposition and had all the facilities that they needed for landing their troops, heavy guns, etc., for the siege of the fortress. Admiral Alexaieff, many hundreds of miles away, reported to the Czar that the port had been made quite useless before it was captured, but, like so many of his comforting reports, it was quite incorrect. Only one iron pier was wrecked; the docks were intact and made it an invaluable base; while the workshops, complete with expensive machinery, immediately started to turn out munitions required at the front.

Japanese Exploitation

Immediately after the war, the Japanese opened it as a free port, making the most of the advantages of its excellent harbour, which is largely natural and well sheltered, with an open approach through good water, as well as being the only ice-free port on the North side of the Yellow Sea. They immediately started to improve the port with very extensive storage and railway facilities all round the wharf area. Their equipment was admirable; with the inner harbour dredged to 30 feet, they improved the quays by degrees, greatly accelerating the work between the two wars, so that it can now claim to be as good and well equipped a port as is to be found East of Suez, with a very considerable number of cranes, special storage for beans and bean oil, up-to-date coaling facilities, and everything else that could be desired. It has been administered by the South Manchurian Railway for the Japanese Government of Kwantung who, among other things, provided free pilotage into the port and tug services for berthing and unberthing ships.

It was used by the Japanese Government in typical Japanese fashion to cheat its own measures. While shipping was being very heavily subsidised, the ship-building industry, largely in the hands of the big trading families, Mitsubishi and Mitsui, claimed its share of the umbrella, and, by political pressure, secured a heavy import duty on foreign ships purchased by Japanese owners. When this was granted, and the usual *quid pro quo* extracted by Tokyo, Dairen was declared to be outside its scope and was immediately used for the registration of a very large number of purchased ships, particularly tramps of considerable age which seldom, if ever, went near it. The concession was later modified for revenue purposes, but the port retained valuable privileges until its surrender.

Dry Dock Accommodation

A subsidiary of the Kawasaki Dockyard Company of Kobe built a dry dock, 440-ft. long by 51-ft., but with a rather shallow sill, and shortly before the outbreak of war the railway made preparations to build a larger and better one. This was made necessary by the authorities withdrawing the facilities of the Port Arthur dry dock from commercial shipping, reserving them for the Navy from the beginning of the "Chinese Adventure" and their plans for the conquest of the Pacific. Dairen was also classified as an auxiliary naval base and given the nucleus of a naval organisation, but it was very little used for that purpose and care was taken not to interfere with its commercial work, which became more and more important as the Japanese obtained a firmer hold of North China and looted it thoroughly.

Until Japan became too aggressive, Dairen took an immense amount of the trade to and from Russian Manchuria from Vladivostock, in addition to doing a vast business for itself and its immediate hinterland. Its principal imports were flour, iron and steel manufactures and machinery, oil, fruits and vegetables, railway material, gunnies, etc.; and its exports, soya beans, cake and oil, coal, kaolin, metals and the like, although, needless to say, the greater part of this business was for the benefit of Japan and not for the unfortunate Chinese, who were merely the labourers under conditions little removed from slavery. Now, for the first time, there is the certainty of the port being properly used and its advantages economically developed.

F. C. BOWEN.

Leith Docks Traffic.

Peace-time operations have been resumed along the East Scottish Coast rather more quickly than on the West, with Leith as a focal point for traffic from the Scandinavian, Continental and American ports. At present, traffic consists largely of imports, including Swedish pulp and timber, grain and timber from Canada and Danish produce. Developments completed during the war years by the final erection of breakwaters, now give the port about 30 acres of the 250 acres which were to be reclaimed for the purpose of establishing industrial plants. A rather serious blow to the port has been the loss of coal export trade which, pre-war, was a major activity, and in view of its possible development on a very large scale, additional facilities had been planned.